SCIENTIFIC AGRICULTURE

Vol. XII. APRIL, 1932 No. 8

FAULTY DIET AS A FACTOR IN DISEASE[1]

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It has always been commonly believed that the amount and kind of food eaten affect susceptibility to disease, and the experience of the race fully justifies this belief, for pestilence has always followed on the heels of famine. In the folklore of dietary customs there are many illustrations of the belief that not only the amount but the kind of food is important for health. Various fruits and herbs have had for centuries the reputation of conferring upon the eater a degree of immunity against some disease or other.

It is remarkable that in spite of this widely held belief which was shared by many medical men, it is only within the last 10 or 15 years that systematic investigation on the subject has been undertaken. The delay in applying our modern wealth of biological knowledge to this subject is due to the fact that the attention of the medical profession has been directed too exclusively to the micro-organisms which cause disease. The discovery of the existence of these organisms and of the connection between some of them and the infectious diseases which they cause has enabled us to to reduce to the vanishing point some of the great epidemic diseases which in former times swept across countries decimating the population. It is not to be wondered at, therefore, that for more than half a century after this great discovery the main weight of medical research should have been devoted to the exploitation of this new light on the cause of disease to the neglect of the fact that the condition of the host may be a factor in determining whether or not these organisms gain entrance to the tissues and there produce the disease of which they are the primary cause.

Recent advances in the science of nutrition are now leading us to pay more attention to the condition of the host as a factor in disease. Since the beginning of the present century it has been established that there are a number of disorders known as 'deficiency diseases' which are caused not by the presence of either micro-organisms or any other toxic agent, but are due to the absence of some constituent in the food. These diseases can be produced or prevented at will on experimental animals by withholding certain nutrients from, or including them in the ration. Much of this information is now being applied in practice to the great benefit of the race. Thus we are able to prevent or cure certain diseases such as scurvy, beri-beri, rickets and pellagra which have caused a great amount of human suffering. Success is also attending the application of this know-

[1]Summary of a lecture delivered to the Eastern Canada Society of Animal Production, Guelph, Ontario, June 24, 1931.

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ledge by the reduction of disease among domestic animals. Rickets, osteoporosis, styfsiekte, goitre and anaemia which in the past have been accountable for heavy losses are now being prevented by proper feeding.

The discovery of these deficiency diseases, due to the absence of certain nutrients which are in most cases either vitamins or minerals, marked an important advance in our knowledge of the etiology of disease and our power to combat it. The practical importance, however, is greater than the mere prevention of these specific deficiency diseases. It has been noted that, according to the extent of the deficiency, there may be all stages of malnutrition from normal health to the gross signs of disease as seen in the moribund animal. The manifestations of the minor degree of deficiency which are common to most of these diseases are decreased appetite, lowered vitality, lethargy, dull coat, lowered capacity for work or production, and in young animals, sub-normal rate of growth. Now, a point of great practical importance is that when under ordinary conditions these diseases appear, though only a few animals may show gross signs of disease, nearly all of the animals under the same dietary conditions show minor symptoms of deficiency. Young animals are incapable of making the maximum rate of growth. Full grown animals are incapable of producing to the full height of their capacity and none of the animals are capable of making 100 per cent utilisation of the feed. This can be well exemplified from the data of feeding experiments. Thus, for example in the case of pigs, the ration can be so adjusted that the rate of growth is only a half or a quarter of that obtained in comparable pigs on a complete ration, whereas the amount of food consumed per pound of gain may be two or three times that in the case of the animals on a complete well balanced diet and therefore in perfect health. The great loss in farming is not the relatively small number of animals which die from rickets, goitre, primary anaemia or styfsiekte, but the large number of animals which are not in perfect health and therefore not 100 per cent efficient as transformers of their feed into the desired animal product.

There is another aspect of the subject which may turn out to be of even greater importance for the welfare of the human race and the efficiency of stock farming. It is beginning to be realised that animals suffering from any degree of malnutrition due to an inadequate diet may be more susceptible to some infectious diseases than animals in perfect health. Let us consider some of the grounds for this belief. In the study of rickets it has been found that the composition of the blood of a rachitic animal is abnormal. The level either of serum calcium or inorganic phosphorus, or of both, is too low. It is most probable that these gross changes in composition may be associated with other changes which are too subtle to be determined by chemical analysis. Hence, the deficiency in the diet that causes rickets causes also changes in the circulating fluids of the body. As a matter of fact, the primary change is in the circulating fluid. The bony deformities are the later results and outward clinical signs of this change. There is reason to suspect that if the nature of the diet can make the blood so abnormal that a gross condition like rickets is produced, the abnormal condition may also affect the working of some of the defence

mechanisms which protect the body against bacterial or protozoan infections.

Deficiencies in the diet may also lead to a disturbance of the normal healthy functioning of the organs. In some recent work it has been shown that in animals on an inadequate diet the rhythmic peristalsis of the intestine is disturbed, leading sometimes to excessive movements, but more frequently to delay in emptying the bowel. In tetany, which is dietary in origin, there is a marked disturbance of the nervous system. It is most probable that these disturbances of the functioning of the alimentary or nervous system are accompanied by derangement of function of other organs.

There is evidence that in malnutrition due to faulty diet the entrance to the body of pathogenic organisms may be facilitated. In most cases of infection invasion takes place by the mucous membranes of the intestinal or respiratory tracts. Histological examination of the tissues of animals suffering from deficiency disease has shown that these mucous membranes are frequently in a pathological condition in which the normal resistance to invasion is weakened.

We have seen that deficiencies in the diet may lead to abnormalities in the composition of the blood and derangement of function of organs which are likely to embarrass the defence mechanisms of the body and in addition to lower the vitality of the mucous membranes where invasion by pathogenic organisms takes place.

These results of recent biochemical and histological work on deficiency diseases would lead us to expect that under those conditions resistance to some diseases at least would be reduced. Observations made on groups of experimental animals lend support to this supposition. It has been repeatedly noted that the death rate due to infections of the respiratory or alimentary tracts is higher in groups of experimental animals fed on deficient diets than in comparable animals fed on complete diets. Classical examples of the association of deficiency in the diet with increased susceptibility to disease are the development of xerophthalmia in rats and of epithelioma contagiosa in fowls. Both these diseases are due to microorganisms, and are liable to develop in animals on deficient diets. But their development can be prevented by the addition of cod liver oil to the diet, even though the animals are in the same environment and subject to the same infections.

The results of these recent investigations warrant us in accepting the view that in animals fed on inadequate diets, the invasion of pathogenic organisms is favoured and the organisms, having gained entrance, find in the abnormal tissues and fluids of the body an enfeebled resistance to their multiplication and to the production of their toxic products which give rise to the specific signs of infection. This view is being accepted as a working hypothesis at several centres of research where the subject is being intensively investigated. On account of the complexity of the problems, these investigations are beset with difficulties and the advance in knowledge is likely to be slow. There is great need for more work of the kind to which we have referred, for it is this fundamental research on the biochemical,

histological and immunological abnormalities due to faulty diet which alone can yield the information we urgently need in this new aspect of the fight against disease.

So far, we have referred only to the results of investigations on experimental animals. The question of practical importance is, to what extent do these deficiencies in the diet occur under ordinary conditions among man and animals, and if they do occur, to what extent can they be correlated with sickness and death rate? A few years ago some investigations on both human beings and animals under ordinary conditions were undertaken from the Rowett Institute to throw light on these points. An enquiry was made on the nature of the diet and of the incidence of disease in two African tribes with different dietary habits. The diet of one of the tribes consisted mainly of cereals. The calcium content was low and this was most probably associated with deficiency of vitamin A, though the vitamin content of the diet could not be determined. The diet of the other tribe consisted mainly of milk, raw blood and meat. It was very rich in both calcium and vitamin A, which were deficient in the former tribe, though, of course, it was defective in other respects.

A survey of the incidence of disease taken in the native reserves showed that in the tribe on the cereal diet pulmonary conditions, especially bronchitis and pneumonia accounted for 31 per cent of all cases of sickness: tropical ulcers for 33 per cent and pulmonary tuberculosis for 6 per cent. In the meat-eating tribe with a high calcium and high vitamin A intake, the corresponding figures were 4, 3 and 1. On the other hand, this tribe suffered extensively from rheumatoid arthritis and intestinal stasis which were the most prevalent diseases. This survey is not regarded as more than a preliminary enquiry. The results, however, are so striking that they seem to warrant the belief that there are native tribes in Africa whose customary diet is deficient in certain nutrients and that these deficiencies lower resistance to some diseases, the primary cause of which is invasion of the body by pathogenic organisms.

There has just appeared an account of another investigation carried out with the same object, but on different lines to the enquiry on the African tribes. At the Pasteur Institute in Southern India groups of rats were fed on diets resembling those eaten by different peoples in India. One group received a diet similar to that eaten by certain peoples in Northern India "among whom some of the finest physical specimens of mankind are to be found". The diet consisted of whole meal flour, unleavened bread, butter, a legume, carrots and cabbage, milk and raw meat with bones. So far as our knowledge goes this should supply a complete and adequate diet. For the two and a quarter years during which they have been under observation, these animals kept remarkably free from disease. Other groups were fed on faulty diets, the materials for the diet being those in use by the people of India; sometimes actual Indian dietaries were used. These were ill-balanced diets, composed mainly of cereal grains or cereal products, with very little milk, butter or fresh vegetables. In this group there was a high incidence of disease. Many of the diseases noted, such as infections of the respiratory and gastro-intestinal tracts are similar to those found in human beings.

These two investigations carried out quite independently and on different lines, point to the same conclusion, viz: that in native races where there is a high incidence of disease, deficiencies in the diet may be an important, and probably the most important etiological factor.

This condition of affairs may exist in many native races with a low standard of living, but is there any evidence to show that the dietaries of civilised countries are so inadequate that the resistance to disease of the individual is sub-normal? An enquiry to obtain some information on this point was carried out a few years ago by the Rowett Institute. A dietary survey was made of 600 working class families in the seven largest Scottish towns. The enquiry was concerned mainly with the question as to whether or not the diets were sufficient to support maximum growth and maintain perfect health in children. It was found that, though the energy value of the diet was abnormally low, in only two cases there was in the greater proportion of the dietaries evidence of deficiency of some of those nutrients the absence of which causes deficiency diseases. The intake of either calcium or phosphorus, or both, was too low in about 25 per cent of the cases. The intake of iron was too low in over 50 per cent of the cases, and the intake of protein, though sufficient for adults, was below the optimum requirements for children in about 40 per cent of the families. Unfortunately, it was impossible to determine exactly the vitamin intake, but it is most probable that there was also deficiency of some of these.

We cannot place too much importance on these findings, because too little work has been done to enable us to know with certainty the requirements of the child for some of these constituents. It is possible that the standard of requirement which we assume from the limited data available is too high. The results, however, appear to be of significance when considered in the light of another test which was made on children in the same districts. In that test it was found that the addition of milk, either whole or separated, during a seven months' experimental period was accompanied by a rate of growth about 20 per cent greater than that in children not receiving the extra milk. The clinical examination of the children showed that the increased rate of growth was accompanied by an improvement of the general condition. It should be noted that the additional milk would completely make good all the deficiencies with the exception of iron. If the results of these investigations on Scottish school children can be accepted as reliable, they indicate that even in our highly civilised communities the diet of a large section of the population is inadequate for the rearing of perfectly healthy children with a high resistance to disease.

Concurrently with these studies of the subject in human populations, observations have been made on sheep kept under natural conditions. A few years ago an enquiry was undertaken to ascertain whether there was any dietary factor involved in the high death rate in sheep in the Western Highlands of Scotland. As pasture is the chief, and in many cases the sole food, an exhaustive investigation was made on the chemical composition of the pasture in those areas as compared with that of pastures in areas where disease was much less prevalent. It was found that in the areas with the high incidence of disease the pastures were relatively poor in certain mineral ingredients and to a lesser extent in proteins. It was

thought that they might also be poor in some of the vitamins. Tests were carried out on various hill farms to ascertain whether the feeding of substances thought to be deficient in the pastures would be followed by improved nutrition and decreased mortality. These tests were so complicated by the handling of the sheep for commercial purposes, that it was difficult to get reliable data. The general results, however, seemed to indicate that in areas where mortality was high improved nutrition accompanied by a decrease in mortality followed the supplementary feeding.

The results were sufficiently promising to warrant making provision for work under more exact conditions, and a sheep farm was taken over along with the existing stock, so that the workers might have complete and continuous control of the animals. It should be noted that the animals under observation on this farm were not put upon special diets nor confined under artificial conditions. They were allowed to remain grazing on the hill, their diet, with the exception of the additions made to the experimental groups, consisting of the natural grazing on the hill.

Observations were made throughout a full year on the clinical state of the animal, especially changes in body weight, birth rate and death rate, on the chemical composition of the blood and on immunological reactions of the blood. It was found that under these natural conditions the animals lost weight during the winter and early spring, the loss in animals under a year old, which were still growing, being as much as 30 per cent; whereas similar animals kept on good pasture made slight gains. Chemical examination of the blood showed that there were changes in both serum calcium and inorganic phosphorus. In the case of the calcium the fall reached as low as only 70 per cent of the normal in the early spring. Accompanying these changes in the clinical condition of the sheep and the chemical composition of the blood there were changes in the immunological reactions of the blood serum.

In the following year some extra food in the form of maize was given to one group of animals, and calcium salts and cod liver oil to another group. The addition of the maize reduced the loss in weight, and the addition of the calcium salts and cod liver oil reduced the fall in serum calcium. In both cases there was an increase of over 10 per cent in the birth rate and a decrease of 40 per cent in the death rate as compared with the control group which received nothing in addition to their grazing.

As the effects of these additions have only been observed for one year, it would be very unwise to place too much importance on the birth rate or death rate figures. If these indicate a true result there should be a cumulative effect which will be more evident in the second and third generations.

At the Onderstepoort Veterinary Research Station in South Africa, observations of a somewhat similar kind have been made in cattle grazing on pastures markedly deficient in phosphorus. It has been found there that the inorganic phosphorus of the blood of these animals is abnormally low and that the level can be raised by the feeding of any phosphorus-rich food stuff and that the rise in blood phosphorus is accompanied by an improvement in the condition of the animals.

It should be clearly understood that in the case of the sheep in Scotland in calcium deficient areas, and the cattle in South Africa in phosphorus deficient areas, there is known to be a marked deficiency of one at least of the essential nutrients. They are, therefore, extreme cases. While observations on them throw light on the general problem of nutrition in relation to disease, they give little information with regard to stock farming under more intensive conditions where the diet is more varied. Among these animals there is, of course, a very high sickness rate. Indeed, loss from sickness and disease is the biggest difficulty which the stock farmer has to contend with. But to what extent malnutrition due to deficiencies in the food increases the susceptibility of these animals to some of the prevalent diseases is quite unknown. The problem is obviously one of great economic importance. Indeed, it is undoubtedly the field of nutrition of greatest practical importance at the present time.

In conclusion it should be emphasized that although some of this very recent research in nutrition seems to indicate that the nature of the diet is an important factor in determining the susceptibility of men and animals to some infectious diseases, we must guard against over-emphasizing the importance of this and consequently under-estimating other aspects of the fight against disease. Nothing learned in the last ten years contra-indicates the extensive measures being taken in both human and veterinary medicine in the direct attack upon pathogenic organisms which are primary causes of infectious diseases. These measures have been highly successful. If, in addition to these, we can take measures to increase the resistance of the individual to infection there are grounds for belief that in the future we may see a still further reduction in the amount of disease amongst men and domestic animals.

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NATURAL CROSSING IN WHEAT, OATS AND BARLEY AT SASKATOON, SASKATCHEWAN [1]

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[Received for publication October 28, 1931]

Introduction

The status of natural crossing in cereal crops has changed during recent years from that of an interesting biological phenomenon to that of a problem of economic importance. It occurs to a sufficient extent to be a disturbing factor in seed production, breeding work and inheritance studies. The amount of natural crossing varies considerably in different crops, species and varieties, and in different environments. Carefully planned studies on natural crossing would seem to be desirable in any area where cereal breeding and other work, involving different varieties is being conducted.

Review of Recent Work

During the past fifteen years frequent cases of natural crossing have been reported from various parts of the world, and numerous special studies made to ascertain the amount occurring in different crops. In 1915 and 1916 Hayes (*11, 12*) at St. Paul, Minnesota, found from 1 to 2 per cent of natural hybrids in wheat varieties. Cutler (*3*) in 1919 reported that numerous natural crosses occurred in wheat at Saskatoon, Saskatchewan. In the same year Howard, Howard and Khan (*16*) in India reported finding many natural crosses in wheat. Percival (*20*) concluded in 1921 that "sports" in wheat were frequently the result of natural crossing. Jenkin (*17*) observed nearly 1 per cent of natural hybrids in a Welsh wheat variety. Garber and Quisenberry (*5*) found about 1 per cent of natural crossing in winter wheat in 1921. In 1924 Carne and Limbourn (*1*) reported natural crosses in ten oat varieties and three barley varieties at Merridin, West Australia. Nicolas (*19*) reported four natural crosses in an awned French variety. Hayes and Garber (*13*) in 1927 concluded from several years' work that at least 2 to 3 per cent of natural crossing occurred in wheat at St. Paul, Minnesota. Garber and Hoover (*4*) reported 0.54 per cent of natural crosses in the F_4 of Gopher × Black Mesdag oats. In 1929 the writer (*9*) found a number of natural crosses in samples of Marquis grown for a study of admixtures. The crosses proved to be between Marquis and bearded varieties. As the samples were from farmers' grain delivered at elevators, the natural crossing evidently resulted from the fertilization of Marquis florets by pollen blown from the occasional bearded admixtures in the field. In 1930 the writer (*10*) reported on a study of a strain of Marquis wheat which consisted of two diverse types and a motley array of intermediate plants. The results of progeny tests and artificial crossing of the two types indicated that natural crossing was responsible for most, if not all, of the intermediate plants, which composed 23 per cent of the strain. In 1930 Coffman and Wiebe (*2*) reported an average of 1.28

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per cent of natural crossing between light and dark kernelled oat varieties at Aberdeen, Idaho.

Self sterility seems to be an important factor favoring natural crossing. Hilgendorf (*15*) in New Zealand reported in 1923 an interesting case of a large number of natural crosses in a variety which, in the previous year, had many of its anthers frosted but no injury done to the stigmas or ovaries. Wakabayashi (*26*) found more natural crossing in Red Rustproof oats than in Black Tartarian, and attributed it to the greater self sterility of the former. Goulden and Neatby (*7*) at Winnipeg, Manitoba, found a close association between self sterility and propensity toward natural crossing in pure lines of Marquillo wheat. Some of the lines showed well over 10 per cent of crosses in 1928. Leighty and Taylor (*18*) reported that at Arlington, Virginia, in 1924 the secondary tillers of five common wheat varieties produced on an average almost six times as many natural crosses as the primary culms. They considered it highly probable that the secondary tillers were more self-sterile than the primary ones.

The amount of natural crossing is also influenced by seasonal conditions. Pridham (*21*) and Tschermak (*25*) considered that dry, hot weather at flowering time favors natural crossing. Garber and Quisenberry (*6*) found many more natural crosses in oats at Morgantown, West Virginia, in 1922 than in the wet seasons of 1923 and 1924. The natural crossing between varieties of *Avena sativa* averaged 0.013 per cent, but between Fulgham and Victor there was 0.41 per cent.

Various investigators have found seasonal effects to be unimportant as compared with varietal differences. Guffee and Hayes (*8*) found natural crossing in oats in 1921 and 1922 at St. Paul, Minnesota, varied from 0.08 per cent in Victory to 2.8 per cent in Kanota. Variations due to seasonal effects were negligible. Stevenson (*24*) in 1928 reported on a barley study covering three years. Varietal differences outshone the seasonal differences, the variations being from 0.00 per cent natural crossing in Hanna and Oderbrucker to 0.09 per cent in Consul. Leighty and Taylor (*18*) found extensive natural crossing in wheat at the Arlington Station, Virginia, in 1917, 1920 and 1924, but the amount did not seem related to either rainfall or temperature. Variety differences, however, were pronounced, and the amount of natural crossing varied from 0.00 to 34 per cent. In 1931 Robertson and Deming (*22*) reported that *Hordeum deficiens nudideficiens* averaged 9.9 per cent of natural crossing during the period 1927-1929, whereas Trebi had only 0.01 per cent and Colsess 0.02 per cent; seasonal differences were not important.

Even different strains of the same variety may show wide differences in their amount of natural crossing. Stanton and Coffman (*23*) found that the amount of natural crossing in oats at Akron, Colorado, varied from 0.00 per cent to 4.28 per cent in different strains of the variety Iowar. Distinct differences between strains of Pringles Progress were also found. Coffman and Wiebe (*2*) at Aberdeen, Idaho, report that the amount of crossing in some progeny rows of Richland oats varied from 0.19 per cent to 6.62 per cent.

The present study was commenced in 1925 in order to determine the amount of natural crossing occurring in common varieties of wheat, oats

and barley and the influence of weather conditions upon natural crossing at Saskatoon, Saskatchewan.

Materials and Methods

Varieties commonly grown in Saskatchewan were used as far as possible. These varieties are described in table 1 in pairs with respect to the differential characters that were employed in the detection of natural crosses.

Table 1.—*Description of varieties with respect to characters used in identifying natural crosses.*

Variety	Sask. No.	Contrasted characters of varieties, and expected characters of natural hybrids.
Wheat		
Marquis	7	white glumes, tip awns
Huron	1252	brown glumes, long awns
F_1		brown glumes, long tip awns
Preston	1090	long awns
Early Triumph	609	no awns
F_1		slight tip awns
Kahla	47	black glumes
Pentad	1215	white glumes
F_1		black glumes
Mindum	1214	brown glumes
Pentad	1215	black glumes
F_1		black glumes
Oats		
Liberty	1233	hulless
Gold Rain	1227	hulled
F_1		intermediate
Gold Rain		yellow grain
Bl. Tartarian		black grain
F_1		black grain
Banner	99	white grain
Black Victor	1230	black grain
F_1		black grain
Barley		
Hannchen	229	two rows, long awns
White Hulless	1232	six rows, hoods
F_1		two rows or intermediate, elongated hoods
Velvet	1239	six rows, smooth awns
Hannchen	229	two rows, rough awns
F_1		two rows or intermediate, rough awns.

Each pair of varieties were sown in rod rows, the varieties being placed in alternate rows, six rows of each. The rows were a foot apart and were sown early in May at the usual acre rates. The date of sowing was regulated to allow the two varieties to blossom at the same time. As no two varieties react in the same way in two consecutive seasons, it was necessary each year to sow several sets of each pair of varieties to insure simultaneous blossoming. Thus, in the case of Early Triumph and Preston the results for several years show the latter to blossom about three days later than the former, but in some seasons this difference is larger and in others it is negligible. Consequently, in one set of rows Early Triumph and Preston were sown on the same day, in another Preston was sown four days earlier, and in a third set this variety was sown a week earlier.

At flowering time the set of rows in which the varieties flowered simultaneously was marked for harvest and the other sets were not used. In the first year 20 pairs of varieties were sown, but only nine pairs were used, owing to lack of simultaneous flowering in the others.

Only those varieties were harvested that were recessive in one or more easily discernable characters, such as awning or chaff colour. The harvesting in each variety was done by taking all of the plants from the central ten feet of the two centermost rows. Such plants had been well surrounded by plants of the contrasting variety. The harvested material was threshed in bulk for each variety.

The following year this seed was sown in eight rod rows, a foot apart, with the seeds about three inches apart. At harvest time every plant was examined, and all that appeared to be natural hybrids or were of doubtful identity were harvested individually.

Progeny tests were made on each of these plants the next season by growing 50 to 100 plants in the nursery. This test revealed at once whether a culture was a hybrid (segregating) or just an admixture (true breeding), and it was usually possible to estimate quite closely the probable male parent.

The project was continued for five years, 1925-1929, for wheat and oats, and for three years, 1925-1927, for barley. The final progeny tests on the natural crosses that occurred in 1929 were made in 1931. Owing to the necessity of ascertaining not only the importance of varietal differences with respect to natural crossing but also the influence of the weather, complete weather records for the flowering period of each season were obtained from the Physics Department of the University of Saskatchewan. These records will be discussed in relation to the results on natural crossng.

Results

Natural Crossing in Wheat:

The summarized natural crossing results on wheat are given in table 2. The project was carried with several pairs of varieties for three years, and then continued with Preston and Early Trumph for two years more. The total number of natural crosses observed during the five years was 288. The amount of natural crossing was 0.88 per cent, the range being 0.00 per cent to 2.16 per cent. These figures were obtained by doubling the actual observed amount, since undetected natural crossing between plants in the same row may in general be assumed to occur as frequently as between plants of adjacent rows. The average amount for the Preston-Early Triumph pair of varieties was 0.92 per cent. The durums alone showed no natural crossing in 1925, 0.3 per cent in 1926 and 0.62 per cent in 1927. During the 1925-1927 period the highest amounts of natural crossing were in the more humid seasons and the least amounts in the dry season of 1926. Eleven per cent of the observed natural crosses were not between the members of individual pairs of varieties but only involved one member of any given pair, the other parent being some variety other than the adjacent one. These are described briefly in the last column of table 2.

TABLE 2.—*Summarized natural crossing results on wheat for five years.*

Female parent variety	Avg. date of flowering, July	Year of test	No. of plants	Observed natural crosses		Estimated % of N.C.	Adjacent male parent variety	Avg. date of flowering, July	Description of male parent of the N.C.'s that were between the female parent variety and varieties other than the adjacent one.
				No.	%				
Preston	8	1925	4032	13	.32	.64	E.Triumph	9	Male parents of 6 N.C.'s had white chaff & tip awns.
Early Triumph	9	1925	3950	28	.71	1.42	Preston	8	Male parent of 1 N.C. had brown glumes; that of another was durum.
Huron	9	1925	3955	6	.15	.30	Marquis	9	
Pentad	8	1925	3705	0	.00	.00	Mindum	8	
Pentad	5	1925	4184	0	.00	.00	Kahla	7	
Average*		1925			.24	.47			
Preston	11	1926	4003	12	.30	.60	E. Triumph	10	
Early Triumph	10	1926	4976	2	.04	.08	Preston	11	
Huron	11	1926	4488	6	.13	.27	Marquis	11	
Marquis	11	1926	4013	18	.45	.90	Huron	11	Male parent of 1 N.C. had white chaff.
Pentad	11	1926	2930	4	.14	.27	Mindum	13	
Pentad	12	1926	3590	6	.17	.33	Kahla	12	Male parent of 1 N.C. had pubescent glumes.
Average		1926			.21	.41			
Preston	13	1927	3623	26	.72	1.43	E. Triumph	12	
Early Triumph	12	1927	799	5	.63	1.25	Preston	13	
Huron	17	1927	4403	7	.16	.32	Marquis	17	Male parent of 1 N.C. was not Marquis.
Marquis	17	1927	3418	18	.53	1.05	Huron	17	Male parent of 2 N.C.'s was not Huron.
Pentad	13	1927	3831	36	.94	1.88	Mindum	13	Male parent of 6 N.C.'s was Kahla & of 2 others was a *vulgare* wheat.
Pentad	14	1927	3980	27	.68	1.36	Kahla	14	Male parent of 5 N.C.'s was Mindum, & of 2 others was a *vulgare* wheat.
Average		1927			.81	1.62			
Preston	7	1928	4085	7	.17	.34	E. Triumph	7	
Early Triumph	7	1928	3508	38	1.08	2.16	Preston	7	Male parents of 7 N.C.'s were awned with brown glumes & of 5 others were tip awned with brown glumes.
Average		1928			.63	1.25			
Preston	14	1929	3379	8	.19	.38	E. Triumph	14	
Early Triumph	14	1929	2310	11	.47	.94	Preston	14	
Average		1929			.33	.66			

In addition to the natural crosses that occurred in the project plots, various others were found each season throughout the cereal nurseries in different varieties of wheat.

Natural Crossing in Oats:

The natural crossing results on oats are shown in table 3. There was 9.82 per cent in the hulless variety Liberty in 1925 and a fair amount in 1926 and 1927. The hulled varieties used yielded few natural crosses.

Banner showed none in two out of four years and Gold Rain showed none during the three years it was tested. The average amount of natural crossing for the hulled oats was 0.07 per cent for the five year period. There appeared to be no relationship between the amount of crossing and the seasonal precipitation.

TABLE 3.—*Summarized natural crossing results on oats for five years.*

Female parent variety	Avg. date of flowering, July	Year of test	No. of plants	Observed natural crosses		Estimated % of N.C.	Adjacent male parent variety	Avg. date of flowering, July	Remarks concerning those of the N.C.'s that were not between the female parent variety and the adjacent variety.
				No.	%				
Gold Rain	11	1925	3743	0	.00	.00	Bl.Tartarian	13	
Liberty	6	1925	406	20	4.91	9.82	Gold Rain	9	Male parent of 1 N.C. was a black grained variety.
Average		1925			2.46	4.91			
Gold Rain	14	1926	977	0	.00	.00	Liberty	13	
Liberty	13	1926	1584	4	.25	.51	Gold Rain	14	
Banner	16	1926	4884	5	.10	.20	Black Victor	16	
Average		1926			.12	.24			
Gold Rain	11	1927	1646	0	.00	.00	Liberty	9	
Liberty	9	1927	3099	11	.36	.71	Gold Rain	11	
Banner	13	1927	3110	0	.00	.00	Black Victor	12	
Average		1927			.12	.24			
Banner	10	1928	4928	4	.08	.16	Black Victor	10	
Banner	13	1929	2640	0	.00	.00	Black Victor	13	

Natural Crossing in Barley:

Table 4 gives the summarized results on the natural crossing in barley. The hulless variety Success averaged 0.16 per cent and the hulled varieties 0.07 per cent. Hannchen showed no crosses in 1925 or 1926 and only 0.03 per cent in 1927. Velvet, however, averaged 0.09 per cent for the three years, although it showed no crosses in 1926. With regard to seasonal effects, the results agree with those on wheat, there being more natural crossing in the moist seasons, and less (none) in the dry season (1926).

Natural crosses were also found in the general barley plots and rows each season. These were rare in awned varieties. In the Colsess, a hooded variety, the amount of natural crossing in 1930 must have been extensive, for over 100 apparent natural hybrids were rogued from a quarter acre increase plot in 1931.

Effect of Varying the Opportunity for Natural Crossing:

A special test was made in 1925 to determine the amount of natural crossing in a given variety when the opportunity for crossing was varied.

The method used is illustrated at the bottom of table 5. In wheat the Early Triumph grown in the paired rows of Preston and Early Triumph was used. The "center plants" had the maximum opportunity for crossing with Preston, the "end" plants had less opportunity and the "side" plants had the least. The amount of natural crossing varied with the opportunity, as shown in table 5. The results were: "center" plants 0.66 per cent, "end"

plants 0.51 per cent and "side" plants 0.30 per cent. The total amount of crossing in the "side" plants was 0.60 per cent, for Early Triumph crossed as frequently with Marquis and Huron, which were on one side of it, as it did with Preston, on the other side.

The same kind of test was made in barley with the varieties White Hulless and Hannchen, and in oats with Gold Rain and Black Tartarian, but with negligible results because there was very little crossing in the barley and none in the oats.

TABLE 4.—*Summarized natural crossing results on barley for three years.*

Female parent variety	Avg. date of flowering, July	Year of test	No. of plants	Observed natural crosses No.	Observed natural crosses %	Estimated % of N.C.	Adjacent male parent variety	Avg. date of flowering, July	Remarks concerning those of the N.C.'s that were not between the female parent variety and the adjacent variety.
Velvet	4	1925	4066	2	.05	.10	Hannchen	5	Male parent of 1 N.C. was not Hannchen.
White Hulless	1	1925	3477	2	.06	.12	Hannchen	4	
Hannchen	4	1925	1701	0	.00	.00	Wh. Hulless	1	
Average		1925			.06	.11			
Hannchen	13	1926	3361	0	.00	.00	Velvet	10	
Velvet	10	1926	950	0	.00	.00	Hannchen	13	
White Hulless	10	1926	977	0	.00	.00	Hannchen	13	
Hannchen	13	1926	1003	0	.00	.00	Wh. Hulless	10	
Average					.00				
Hannchen	10	1927	4403	1	.02	.05	Velvet	14	Male parent was a hooded variety.
Velvet	14	1927	3575	3	.08	.17	Hannchen	10	
White Hulless	11	1927	2706	5	.19	.37	Hannchen	11	
Hannchen	11	1927	4111	0	.00	.00	Wh. Hulless	11	
Average					.10	.20			

Effect of Distance on Natural Crossing:

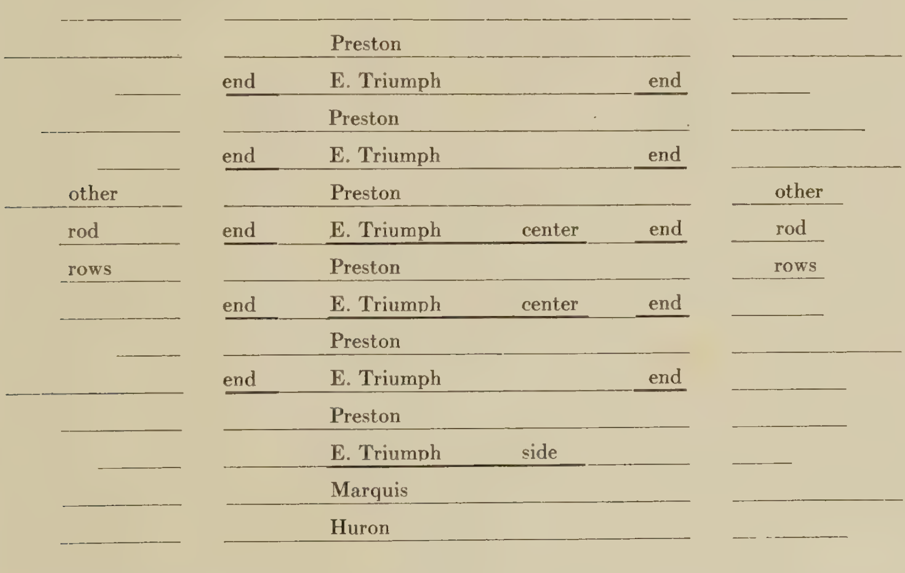
It is of particular interest to examine the data on natural crosses of varieties with others farther away than the adjacent one. This can best be done with the wheat data, since the number of crosses is much larger than is the case with barley or oats. The results are summarized in table 6. In 1925 eight out of 47 crosses were not with the adjacent variety. Six of these were with the nearest other varieties, located an average distance of 7 feet away, and two were with varieties 8 and 14 feet away, respectively. In 1926 only two of 48 natural crosses were not with the adjacent variety. However, the only wheat within 30 feet was a series of paired rows of Mindum and Pentad durums 28 feet away, and some *vulgare* varieties about 30 feet away. In 1927 there were 119 crosses, of which 18 were not with the adjacent variety. Eleven of these were between Pentad and the Mindum and Kahla seven feet away, four between Pentad and *vulgare* wheat presumably the nearby Marquis and Huron, two between Marquis and other *vulgare* wheat about 24 feet distant, and one between Huron and some *vulgare* wheat about 27 feet away. In 1928 twelve of the 45

natural crosses were between Early Triumph and the nearest varieties other than the adjacent Preston. These were Huron and Stanley, and they were about 7 feet distant from the Early Triumph.

TABLE 5.—*The amount of natural crossing occurring between varieties when the opportunity for crossing is varied.*

Female parent variety	Male parent variety	Location of female plants used	No. of plants	Observed N.C.'s between the two varieties		Natural crosses between the female parent variety and varieties other than the intended male parent.
				No.	%	
Early Triumph	Preston	center*	3950	26	.66	1 with brown glumes, 1 with durum.
" "	"	end*	3960	20	.51	1 with brown glumes.
" "	"	side*	3953	12	.30	7 with brown glumes, 5 with tip awns.
White Hulless	Hannchen	center	3477	2	.06	
" "	"	end	2495	1	.04	
" "	"	side	3483	2	.06	1 with blue seeded, 6 rowed.
Gold Rain	Bl. Tartarian	center	3743	0	.00	
" "	"	end	3706	0	.00	
" "	"	side	3640	0	.00	

*As shown below.



Relationship between Natural Crossing and Weather Conditions Prevailing at Blossoming Time:

The investigation covered an excellent period for the study of seasonal effects on natural crossing, for both wet and dry seasons were included. In order to give an adequate picture of the weather conditions at any particular time during the blossoming period, data on temperature, wind, humidity, precipitation and sunshine for the five years 1925-1929 have been summarized in table 7.

TABLE 6.—*Summary of natural crossing of wheat varieties with varieties farther away than the adjacent variety.*

Female parent variety used in N.C. project	Year	Natural crosses not with adjacent variety		Distance away in feet of varieties that could have been male parents of the natural hybrids			Possibility of crossing with other nearer varieties
		No.	%	Nearest	Farthest	Average	
Preston	1925	6	0.30	7	9	7	No
Early Triumph	1925	2	0.10	7	7	7	No
Marquis	1926	1	0.05			30	Yes, durum
Pentad	1926	1	0.06			6	No
Huron	1927	1	0.04			27	Yes, durum
Marquis	1927	2	0.12	22	26	24	Yes, durum
Pentad	1927	15	0.38	7	7	7	No
Early Triumph	1928	12	0.68	7	7	7	No
Total or average		40	0.41	8.8	9.3	8.9	

The data are of particular interest with respect to the natural crossing results on wheat. In 1925 the average amount of natural crossing was 0.79 per cent in the common wheats, although 0.00 per cent in the durums. During the period of flowering there was much rain, the humidity, amount of sunshine and average wind velocity were high, and the temperature varied from high to low. In 1926 the amount of natural crossing was low, 0.41 per cent. The weather during flowering differed from that for the similar period in 1925 by being cooler, drier (practically no rain), less sunny and much less windy. In 1927 a fairly large amount of natural crossing, 1.62 per cent, occurred. The weather for the flowering period, compared with that of 1925, was cooler, but otherwise not very different. In 1928 there was a fairly large amount, 1.25 per cent, of natural crossing. The weather for the flowering period was cooler, more humid and much less sunny than the corresponding period of 1925. In 1929 there was a fairly small amount, 0.66 per cent of crossing. The weather for the first half of the flowering period was cool and very dry, and for the next few days was warm with high humidity and much sunshine. Considering all of the results on wheat, the largest amounts of natural crossing occurred in 1927 and 1928 and the least in 1926 and 1929. The principle difference in weather between these two sets of seasons is the greater humidity of the former as compared with the latter. The results show no clearcut relationship between weather conditions and natural crossing, but they indicate if anything a greater propensity for natural crossing in the more humid seasons.

The natural crossing results on barley show in general the same relationship to weather as do the wheat results. The flowering period in 1925 was moderately warm with fairly high humidity, much sunshine and much wind. In 1927 it was cooler, but otherwise very similar. In both seasons there was natural crossing in all varieties except Hannchen. The flowering period of 1926 differed from that of 1925 and of 1927 in being much drier and much less windy; no natural crossing occurring in this season. A definite connection between humidity at flowering time and natural crossing is indicated. Possibly, also, the results indicate that wind may assist crossing.

TABLE 7.—*Weather record for the flowering period during the seasons 1925-1929, inclusive.*

	June			July																				
	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1925																								
Max. Temp.	79	77	78	84	74	74	86	75	66	51	68	83	68	92	95	91	85	78	81	90	77	64	65	77
Min. Temp.	52	62	58	53	55	50	53	53	47	46	40	48	55	52	61	57	60	54	48	57	57	54	53	46
Hum. 8 a.m.	78	88	73	80	82	79	79	75	83	96	86	75	76	88	62	64	63	63	75	55	66	81	89	72
Hum. 8 p.m.	87	94	87	86	84	84	88	74	91	90	91	90	83	82	66	64	85	79	60	68	57	92	82	64
Precipitation	0	0	.18	0	.10	0	0	0	0	.24	.70	.06	0	0	0	0	0	.03	0	0	0	0	T	.10
Sunshine	13	3	12	13	15	15	6	12	7	0	12	15	12	13	11	15	12	15	14	9	11	0	2	15
Wind velocity	16	8	8	14	14	8	17	15	9	20	10	9	7	9	8	9	9	13	9	10	22	14	6	9
1926																								
Max. Temp.	79	80	82	81	74	73	81	85	93	78	70	65	71	77	78	80	79	80	71	86	69	65	69	73
Min. Temp.	54	55	48	50	60	57	52	56	58	65	60	52	41	53	55	53	59	56	56	50	48	49	44	47
Hum. 8 a.m.	53	61	48	71	82	87	82	64	54	100	78	83	67	59	79	64	68	60	93	73	73	66	77	60
Hum. 8 p.m.	59	54	53	58	82	75	74	55	53	94	95	84	66	69	64	54	72	77	78	73	75	85	84	55
Precipitation	11	0	0	0	.4	0	0	0	1.24	.05	T	0	0	.05	0	0	0	.69	0	0	0	0	.05	T
Sunshine	15	15	11	8	0	6	13	15	14	1	2	5	12	8	13	11	9	11	9	14	12	2	11	14
Wind velocity	3	0	1	2	3	4	1	1	4	3	4	4	1	2	1	3	2	0	1	7	2	6	2	1
1927																								
Max. Temp.	77	64	56	67	71	64	69	60	72	75	76	73	71	77	71	71	77	74	75	73	75	79	79	77
Min. Temp.	51	54	47	42	45	54	56	56	55	53	54	57	52	51	55	53	49	54	49	51	49	57	54	56
Hum. 8 a.m.	57	79	96	75	45	76	71	98	90	72	77	85	69	64	81	93	70	77	72	72	82	70	74	80
Hum. 8 p.m.	67	89	98	78	59	79	87	97	87	74	83	84	62	88	84	87	77	84	72	84	74	68	85	94
Precipitation	0	.04	.10	.59	0	0	1.22	.26	1.43	0	0	0	.5	0	.02	.13	.01	.03	T	.10	0	0	0	.28
Sunshine	15	5	0	14	11	1	4	0	8	16	16	9	11	12	9	8	12	10	9	9	12	12	8	7
Wind velocity	12	8	14	8	14	15	14	11	10	11	9	14	11	6	7	6	6	8	10	5	7	7	5	4
1928																								
Max. Temp.	83	85	74	65	67	68	73	77	74	69	71	75	75	79	82	86	86	75	71	76	75	78	82	76
Min. Temp.	55	54	59	58	57	55	54	54	55	56	58	52	54	64	53	64	62	56	50	48	51	52	48	52
Hum. 8 a.m.	65	54	71	81	97	93	93	72	88	100	72	79	63	72	59	63	80	77	71	62	83	75	72	79
Hum. 8 p.m.	48	64	76	93	100	93	82	78	87	94	87	56	77	93	68	62	72	62	77	70	72	87	80	80
Precipitation	0	0	.32	.51	.2	0	.15	.01	.92	.3	0	.26	0	0	0	0	0	0	0	0	.27	0	.23	0
Sunshine	15	11	1	0	2	6	8	12	6	1	9	15	10	16	15	13	11	15	14	15	4	8	14	12
Wind velocity	6	6	13	13	8	9	9	13	6	7	4	9	8	3	3	3	5	4	7	3	2	3	5	9
1929																								
Max. Temp.	80	75	73	71	79	72	71	74	68	65	64	78	82	74	65	82	90	90	77	73	83	82	100	72
Min. Temp.	49	50	52	46	48	58	54	52	54	52	45	44	54	54	48	45	53	55	62	54	52	61	53	47
Hum. 8 a.m.	72	71	53	51	48	44	57	49	80	93	67	70	65	56	62	35	38	73	64	66	58	56	69	51
Hum. 8 p.m.	58	59	75	50	48	45	51	90	80	71	86	69	71	63	64	57	91	82	66	71	55	76	25	66
Precipitation	T	.07	0	0	0	0	0	.17	.32	.07	.1	0	0	T	0	0	.64	.01	0	0	0	0	0	0
Sunshine	11	11	14	16	15	11	9	8	7	8	5	14	8	12	11	11	16	15	15	16	15	2	15	11
Wind velocity	11	8	5	6	24	22	6	9	10	11	8	10	10	9	9	9	9	11	11	11	18	8	23	11

*All temperatures in degrees Fahrenheit; humidity in percentage of total saturation; precipitation in inches; sunshine in hours; wind velocity in miles per hour.

Max. Temp. (Maximum Temperature); Min. (Minimum); Hum. (Humidity); Precip. (Precipitation); Wind Vel. (Wind Velocity).

The results for oats show no definite relationship to weather. Liberty crossed very extensively in 1925 under conditions of high humidity, but very much less in 1926 and 1927. In 1926 humidity and wind velocity were low. In 1927 humidity was lower than in 1925, but higher than in 1926. Banner yielded no natural crosses in 1927 or 1929 but in 1926 and 1928 there were a few. Humidity during flowering was low in 1929 and fairly low in 1928.

Discussion

The conclusions to be drawn from a natural crossing study should be general rather than specific. Such a study involves much space and routine work, and of necessity is limited in extent. An adequate study would have to cover dozens of pairs of varieties (embracing the different species in use) with each pair sown in various ways with respect to date of flowering and distance apart, and the whole repeated in several different localities for both early and late sowing and for a number of years. No experiment of this scope has been yet attempted, as far as the writer knows. Yet the results that have been obtained from the limited studies made have yielded a large amount of information of practical value to the breeder, farmer, seedsman and geneticist.

Amount of Natural Crossing:

The present study was conducted on a very comprehensive scale for the crosses used. The total number of plants examined was 77,243 in wheat, 27,017 in oats and 30,330 in barley. There was much variation in the amount of natural crossing, some of it being seasonal, but most of it being attributable to differences in crops and in varieties. In each of the crops, wheat, oats and barley, the amount of natural crossing varied considerably, although much less so in barley than in the others. In wheat the range was from 0.00 per cent to 2.16 per cent with an average of 0.88 per cent for the five year period, or one natural cross in every 114 plants. This amount is large enough to be a distinct disturbing influence. In oats the hulless variety used showed much more crossing than did the hulled varieties, the amount being nearly 10 per cent in 1925. The hulled varieties averaged only 0.07 per cent for the five years of test, or one cross in every 1430 plants. In barley the hulless variety averaged twice as much natural crossing as the hulled varieties, the latter averaging 0.04 per cent, or one cross in 2500 plants. In both oats and barley the amount of natural crossing was relatively unimportant for the hulled varieties, but not small enough to be ignored.

Importance of Weather vs. Varieties:

The study did not indicate any clearcut relation between weather conditions and natural crossing, but the results on wheat and barley showed more natural crossing under humid conditions than under dry conditions. However, the driest season was also characterized by a very low average wind velocity, whereas the more humid seasons had in each case a fair amount of wind. It seems probable that wind velocity may be one of the more important factors concerning natural crossing. The variation in amount of natural crossing was large between different crops and different species and varieties of the same crop. This variation appeared to be more important than differences due to seasonal or weather conditions.

Opportunity for Natural Crossing:

The results showed that natural crossing occurred most often with the adjacent variety and rarely with varieties more than seven feet away. Only five of the 40 crosses that were not between members of a given pair of varieties were with varieties more than seven feet away, although there was ample opportunity for more crosses. Probably such crosses would have been more frequent if all sowings had been made so that flowering throughout the nursery was simultaneous. But it is improbable that the increased number would have appreciably affected the fact that the great majority of the crosses occurred between adjacent varieties. Henry and Tu (*14*), working with flax, recently demonstrated that the amount of natural crossing between the varieties decreased rapidly when the distance between the varieties was increased. There was 1.26 per cent at one foot and 0.33 per cent at five feet. Coffman and Wiebe (*2*) reported in 1930 on an oat experiment where 21 out of 27 white kernelled plants, grown one foot from the nearest black kernelled plant, produced crossed seed. More crossed florets occurred in plants grown one foot from the nearest dark kernelled plant than in those grown at a greater distance.

Practical Considerations:

The most important findings of this and similar studies are the following: (1) Natural crossing may occur sufficiently frequently to be a significantly disturbing factor. (2) The amount of natural crossing is not definitely predictable for any particular crop, variety, season, locality or distance. (3) Natural crossing may be reduced to a minimum by keeping crossable varieties and species well separated in the field.

(1) The present investigation revealed natural crossing in every variety used excepting Gold Rain oats. The fact that Gold Rain did not show crosses with Liberty does not indicate that it would not show crosses if planted beside other varieties. The highest amount of natural crossing was 9.82 per cent in Liberty oats, and the next highest was 2.16 per cent in Early Triumph wheat. If other varieties had been used the amount of natural crossing might have been much higher. In this connection, self sterility should be mentioned, for various pieces of work, reviewed in the introduction of this paper, have shown it to be an important factor favoring natural crossing. Inter-specific hybrids often are more or less self-sterile, and many cases have been recorded in the writer's breeding work[3] where plants could hardly have arisen other than by such natural crossing. Furthermore, one never knows when a hot wind or a light frost at flowering time may kill the pollen in some of the florets and leave the stigmas susceptible to fertilization from outside pollen.

(2) In general one may expect at Saskatoon more natural crossing: (a) in wheat than in oats or barley; (b) in hulless oats and barley than in hulled varieties; (c) between adjacent plants than between those a few feet apart.

(3) Natural crossing may be controlled in various ways. A farmer or seedsman would be well advised to keep crossable varieties at least ten rods apart. If there are only a few rows of each, somewhat less distance

3 Unpublished results.

apart should be satisfactory. This separation principle should be observed particularly for wheat varieties and others that have been shown to cross readily. If pure cultures are desired, the safest and simplest method is to enclose individual spikes in glassine envelopes. Another method, which, however, is not particularly safe, is to separate crossable varieties by several rows of some other crop. The plant breeder may weed out natural crosses in lines that he has had under comparative test for some years by resorting to progeny tests on a hundred or more individual plants in each line.

Summary

1. A special natural crossing project in wheat, oats and barley was carried on for five years at Saskatoon, Saskatchewan.

2. The average amount of natural crossing in wheat was 0.88 per cent, with a range from 0.00 per cent to 2.16 per cent. The average for hulled oats was 0.07 per cent with a range from 0.00 per cent to 0.20 per cent, and for the hulless variety Liberty 3.68 per cent with a range from 0.51 per cent to 9.82 per cent. The average for awned barley was 0.07 per cent with a range from 0.00 per cent to 0.17 per cent, and for the hooded variety White Hulless 0.16 per cent with a range from 0.00 per cent to 0.37 per cent.

3. While the differences between crops and species were large, seasonal effects did not appear to be very important. However, the results seemed to indicate for wheat and barley a greater propensity for natural crossing under humid conditions than under dry conditions.

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WOUND-GUM IN PEACHES AND GRAPES

ITS RELATION TO THE INVASION OF FUNGUS WOUND-PARASITES [1]

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[Received for publication November 5, 1931]

Inoculation Experiments

On the vine.

Mention has already been made of the formation of a brown zone in the wounded wood of the grape. Several series of inoculations were carried on in an attempt to discover whether the presence of this brown region acts as a deterrent to invasion of the wood by *Cryptosporella viticola*, the organism responsible for "dead-arm". Stubs, cut at various times of the year, were inoculated with a suspension of spores of *Fusicoccum viticolum*, the imperfect stage, at various intervals after cutting. After inoculation, the stubs were covered with pads of absorbent cotton moistened with sterile distilled water. These were held in place by wrapping with squares of waxed cloth, secured by means of wire. This was done to provide sufficient moisture for the incubation period. The wrapping was not entirely water-proof, however, as the pads were usually dry when removed three or four weeks later.

Series 1 consisted of stubs cut in September 1927, some of which were inoculated immediately, others, nine months later. In the latter, the brown region was well established. Examinations were made comparatively soon after inoculation so that positive infection cannot be affirmed. However, there was evidence to show that the *Fusicoccum* spores were able to germinate in both freshly cut and browned stubs.

The stubs in series 2 were made in February 1928, and inoculated four, five or six months later. In three cases, the "dead-arm" organism was definitely established since pycnidia were present in the dead bark, and the lesions had increased considerably in size. Seven of the remaining eleven stubs also contained well established mycelium, though the spread of the lesions was not observed. In all cases, the brown region was present before inoculation, so that it would appear that it did not prevent infection.

Four stubs, cut during the growing season and inoculated after one or two months, comprised series 3. Two of the stubs showed a certain amount of penetration by the fungus. In a third, there was a considerable increase in the size of the lesion, due to the activities of the organism.

In series 4, a number of stubs were cut in October, 1928. Five were inoculated at that time and six in July, 1929. One of the former proved of interest because the fungus was present deeper than the brown region and had sporulated in less than eight months after inoculation. At the same time, not much damage had been done to the stub. This bespeaks a certain amount of resistance on the part of the vine, which, incidentally, was of the Niagara variety. As the stub was inoculated at the time of

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[1] A Thesis submitted to the University of Toronto in partial requirement for the degree of Doctor of Philosophy. The first part of this paper was printed in the March 1932 issue of Scientific Agriculture, Vol. 12, pgs 402-419.

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cutting, it favours the idea that the resistance to "dead-arm" elsewhere noted for Niagaras is not due to wound-gum. The fact that one of the extensive lesions mentioned in series 2 occurred also on a Niagara vine, furnishes conflicting evidence regarding the resistance of Niagara, but confirmatory evidence of the unimportance of wound-gum as a protection against attack by *Cryptosporella.*

On peach trees.

It was found that, when stubs were left in pruning, an abundant supply of wound-gum was produced in the full cross-section of the stub. During the summer months the ends of the stubs became completely blocked by wound-gum plugs in less than three weeks. This provided the means of obtaining an adequate wound-gum "barrier" which would have to be penetrated by the invading wound-parasite before the latter could become well established in the host. For this reason, all inoculations were made on stubs, some at the time of cutting, others three or more weeks afterwards, in order to discover if the presence or absence of wound-gum has any marked effect on the ability of the fungus to gain a foothold in the host. Although care was exercised in pruning, no special precautions were taken to insure sterile conditions on the stubs, as, in the nature of things, they would be exposed to contamination between the times of cutting and of the later inoculation. Moisture was provided in the infection court by the means already described in connection with the inoculations on the vine.

Series 1:—The inoculations were equally effective, whether made at the time of pruning or three months later, when wound-gum was abundant in the tissue. In every stub, mycelium was observed inside, but not beyond the wound-gum region, and very often not near its inner limits. Successive examinations showed the mycelium deeper in the tissue, so that in the most recent, mycelium was frequently found in the main branch at some distance from the base of the stub. In these cases, the wound-gum extended much further, with little or no diminution (text figure 4e). In an uninoculated stub, also made on March 1, 1928, the wound-gum region ended a short distance inside the main branch (text figure 4d) and no fungus was seen at the base of the stub. Almost without exception, pycnidia of *Cytospora* were present on stubs of this series in the spring of 1929, and had already appeared on some in the fall of 1928. The pycnidia were usually several inches from the cut end.

Series 2:—Here, the inoculations made at the time of cutting resulted in more infection than those made after the wound-gum had formed. But, even here, in spite of the presence of wound-gum, many of the stubs became invaded, as the occurrence of mycelium deep in the stub and the extension of the wound-gum region into the main branch bear witness. Thus the evidence from this series is by no means contradictory to that from Series 1.

Series 3:—Unfortunately, the trees bearing this series were removed about two months after the stubs were inoculated, consequently it was impossible to be sure that infection had occurred. However, more or less penetration of the stub by mycelium was observed, although all inoculations were made after the tracheae had become occluded by wound-gum.

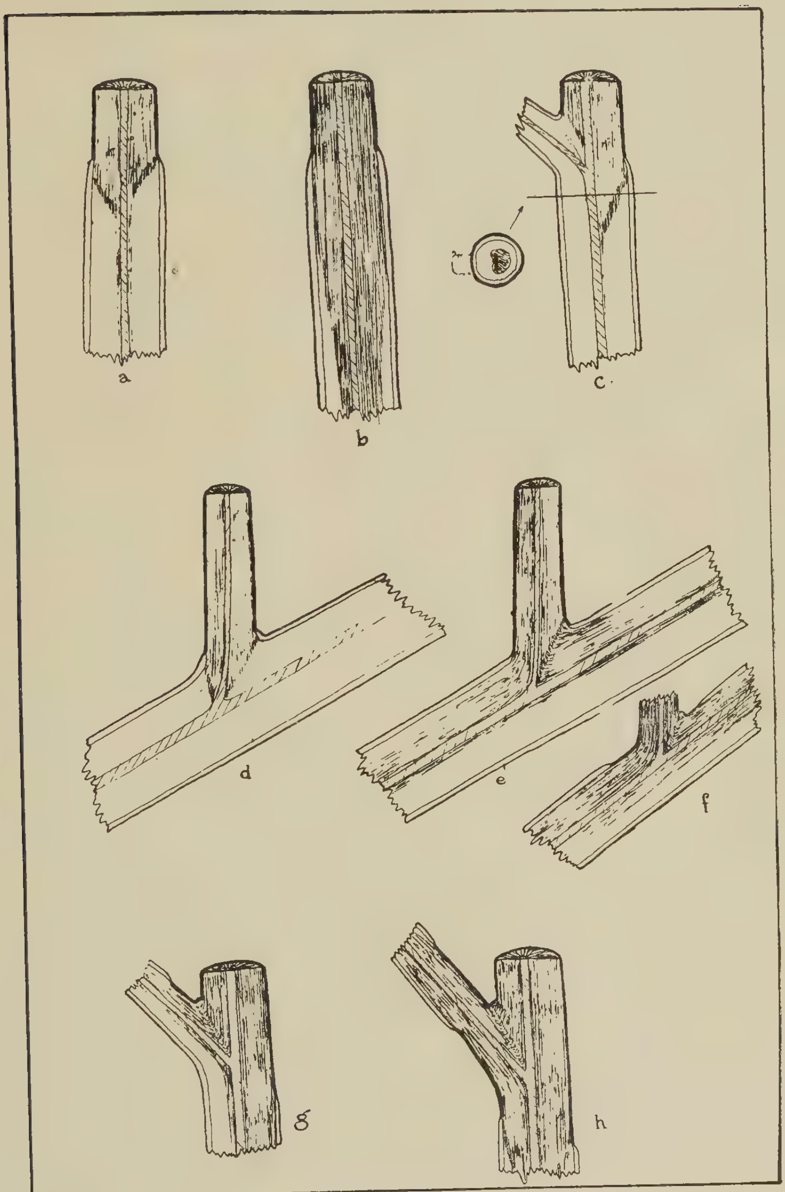
TABLE 3.—*Observations on inoculations of stubs of peach with Cytospora.*

Series No.	Number	Date of cut	Time in days		Pycnidia present +	Mycelium in stub, 0. In branch below stub. + Not observed,-	Observed depth of penetration of mycelium in inches.	Penetration of plugs by hyphae.
			Cut to Inoculation	Inoculation to Examination				
1	A1	1.3.28	110	7	–	0	⅜	–
	A4	1.3.28	110	15	–	0	1	+
	A6	1.3.28	110	84	–	0	2-3	+
	A9	1.3.28	110	108	–	0	2½-3	+
	A7	1.3.28	110	461	+	+	5	+
	A10	29.3.28	82	84	–	0	1	?*
	A13, 14, 15	29.3.28	82	461	+(5)	+(5)	5-27	+(2)
	16, 19	29.3.28	82					?*(3)
	A20	11.6.28	8	461	+	+	12	?
	A3	19.6.28	0	7	–	0	1/16	–
	A8	19.6.28	0	15	–	0	1/16	–
	A12	19.6.28	0	36	–	0		–
	A2, 11	19.6.28	0	84	–	0(2)	1-3	+(2)
2	6	19.6.28	28	8	–	–	–	
	7	19.6.28	28	100	–	0	¾	?
	13, 17-20	19.6.28	28	433	–	0	1¼-3½	?(5)
	A22	17.7.28	0	100	+	0	3	
	A23, 24, 26	17.7.28	0	433	+	+(1)	4½-?	+(1)?(2)
3	B1	31.7.28	21	15	–	–	–	–
	B3	31.7.28	21	21	–	0	¼	–
	B4	31.7.28	21	45	–	0	3/16	+
	B5, 6	31.7.28	21	65	–	0(2)	¼	+(2)
4	C5	20.8.28	1	15	–	0	1/8	–
	C7	20.8.28	1	45	–	0	5/8	+
	C14	20.8.28	8	390	+	0	1	?
5	D1, 2, 8	11.9.28	45	332	–	0	½-¾	?(3)
6	E6, 11	26.10.28	0	332	+	+(1)0(1)	2½-3¼	+(2)
	E9, 14	26.10.28	32	300	+(1)-(1)	+(2)	2½-5	+(2)
7	F1, 7	27.11.28	0	300	+(2)	+(2)	2¼-3¼	+(2)

* ? indicates penetration of plugs not noted but in all probability occurring, judging by the depth o penetration.

Series 4:—The *Cytospora* inoculations were insufficient in number to warrant using them as a basis for conclusions. But, they provide some evidence that the organism is able both to invade freshly cut wood and to penetrate wound-gum plugs.

Series 6:—Infection resulted from all inoculations. The stubs were still free from wound-gum plugs at the time of the later inoculations. In fact none of them became plugged until the following spring. At that time, plugs were obviously formed well in advance of the point to which the fungus had penetrated since penetration threads (see below) were frequently observed. In many cases, too, hyphae were seen embedded, without constriction in the masses of wound-gum. This may be interpreted either as the penetration of soft plugs or as the deposition of wound-gum around hyphae already present. It is quite probable that both phenomena occur.



Text figure 4: Diagrams illustrating the extent of browning in peach stubs: a, c, d uninfected; b, e, f, g, h infected with *Cytospora*.

Series 7:—Only three stubs were inoculated with *Cytospora*. Two of these became infected because pycnidia of this organism appeared in due course. Histological examinations confirmed the evidence obtained from the foregoing series, that the hyphae of this fungus are able to penetrate wound-gum.

TABLE 4.—*Observations on inoculations of stubs of peach with Sclerotinia.*

Series No.	Number	Date of cut	Time in days		Observed depth of penetration of mycelium in inches	Penetration of plugs by hyphae.	Remarks
			Cut to inoculation	Inoculation to examination			
3	B8	31.7.28	21	7	1/16	—	
	B2	31.7.28	21	15	1/8	—	
	B10	31.7.28	21	45	¾	+	
	B11, B12	31.7.28	21	65	3/16–⅜	+ (2)	
4	C1	20.8.28	1	8	1	+	(Hyphae in a few plugs which were formed prior to wounding.)
	C2	20.8.28	1	15	½	—	
	C3	20.8.28	1	21	½	+	
	C9	20.8.28	8	8	1/8	—	
	C10	20.8.28	8	16	1/8	—	
	C11	20.8.28	8	345	—	—	(Stub dead only 7/8–1½″).
	C19	20.8.28	15	31	1/8	—	
	C18	20.8.28	15	289	¼	+	
	C17	20.8.28	15	384	¼	+	
	C20	20.8.28	22	24	1/16	?	
	C21	20.8.28	22	45	1/16	+	
	C23, 25, 28	20.8.28	22	377	¼–1½	?:(2);+(1)	
5	D4	11.9.28	45	243	1/8	—	
	D5, 6, 11	11.9.28	45	332	½–1–1/8	?(3)	
6	E7, 12	26.10.28	0	332	1–1½	?(2)	
	E5, 10	26.10.28	12	300	1–1/8–1½	?(2)	
7	F2, 8	27.11.28	0	300	2–3½	+(2)	Cytospora pycnidia were present on both stubs).
	—	11.6.28	85	384	¾	—	Cystospora pycnidia present.
	—	11.11.27	298	384	3½	+	

Series 3:—The evidence from this series shows that *Sclerotinia* tends to grow in the wound-gum region and to penetrate plugs much as *Cytospora* does. In view of the later results, however, it should be pointed out that these stubs could not be left on the trees for more than two months and, during most of that time, the inoculations were kept moderately moist by the cotton pads and waxed cloths.

Series 4:—It is interesting to note that, in one week, in a stub inoculated at the time of cutting, the fungus has penetrated almost as far as it has in a year in stubs inoculated after the wound-gum barrier has been formed. Also, in several cases, the fungus was able to advance to a considerable depth in a stub without increasing the wound-gum region much beyond the normal extent in comparable uninoculated stubs. In other words, *Sclerotinia* is not particularly effective in its efforts to penetrate through the wound-gum "barrier".

Series 5:—The observations here confirm those of Series 4.

Series 6:—These stubs were inoculated before the appearance of the wound-gum "barrier", but even so, penetration has not gone far, as compared with that in stubs infected with *Cytospora*. The fact that *Sclerotinia* (see below) is unable to grow much at low temperatures and therefore could not establish itself in the winter and spring while the stubs were free of wound-gum is sufficient to account for the relatively slight invasion. This series is an important one as it brings out very clearly the differences between the behaviour of *Cytospora* and *Sclerotinia* with regard to their invasion of wood and their reaction to wound-gum.

Series 7:—The inoculations of this set have been over-run by a natural infection of *Cytospora*. This occurrence is unfortunate in that it renders the series valueless for the corroboration of data already obtained with regard to *Sclerotinia*, but it does serve to show how readily *Cytospora* may gain entrance through pruning wounds.

The two miscellaneous inoculations are interesting. They indicate, first, that *Sclerotinia* is unable to make headway in an old-established wound-gum region, and, second, that *Cytospora* has once more naturally infected a stub.

To provide checks, a number of stubs made at the same time as Series 1, 5, 6 and 7 and also on March 1, 1929 were left uninoculated. These revealed some interesting information. Fungus was not observed in 45 per cent of them; 22 per cent became infected with *Cytospora* to such extent that pycnidia were produced. The remainder contained hyphae of an unidentified fungus up to two inches from the end of the stub. In the stubs not invaded by the wound-parasite the wound-gum region did not extend far below the border of the dead bark, or if so rapidly became narrower (text figure 4, a). On the other hand, in infected stubs it continued for some distance undiminished or only gradually narrowing, according to the severity of the attack (text figure 4, b). If the stub had been cut long enough to have died to its base, the wound-gum region ended just inside the main branch, if infection had not previously occurred (text figure 4, d) but extended a considerable distance down, and sometimes up, the main branch if the stub was badly infected (text figure 4, e, f).

It must be borne in mind that, although the presence of an organism such as *Cytospora* promotes the production of wound-gum, in that it is formed more extensively in invaded tissue, the fungus itself is *not* the cause of wound-gum formation. The latter normally appears in peach wood wherever the tissue dies, if proper conditions of moisture and temperature prevail, regardless of the presence or absence of fungi. The fact that it is more widely distributed when the fungus is present is only evidence that a greater amount of killing has occurred. Thus, the fungus is only indirectly responsible, in that, by some means or other, possibly by the secretion of a toxic substance, it is able either to severely injure or to kill the host tissue.

There is a rather high percentage of natural infection on the part of *Cytospora*. The check stubs were made near either the beginning or end of the dormant season. During this period infection seems to occur more

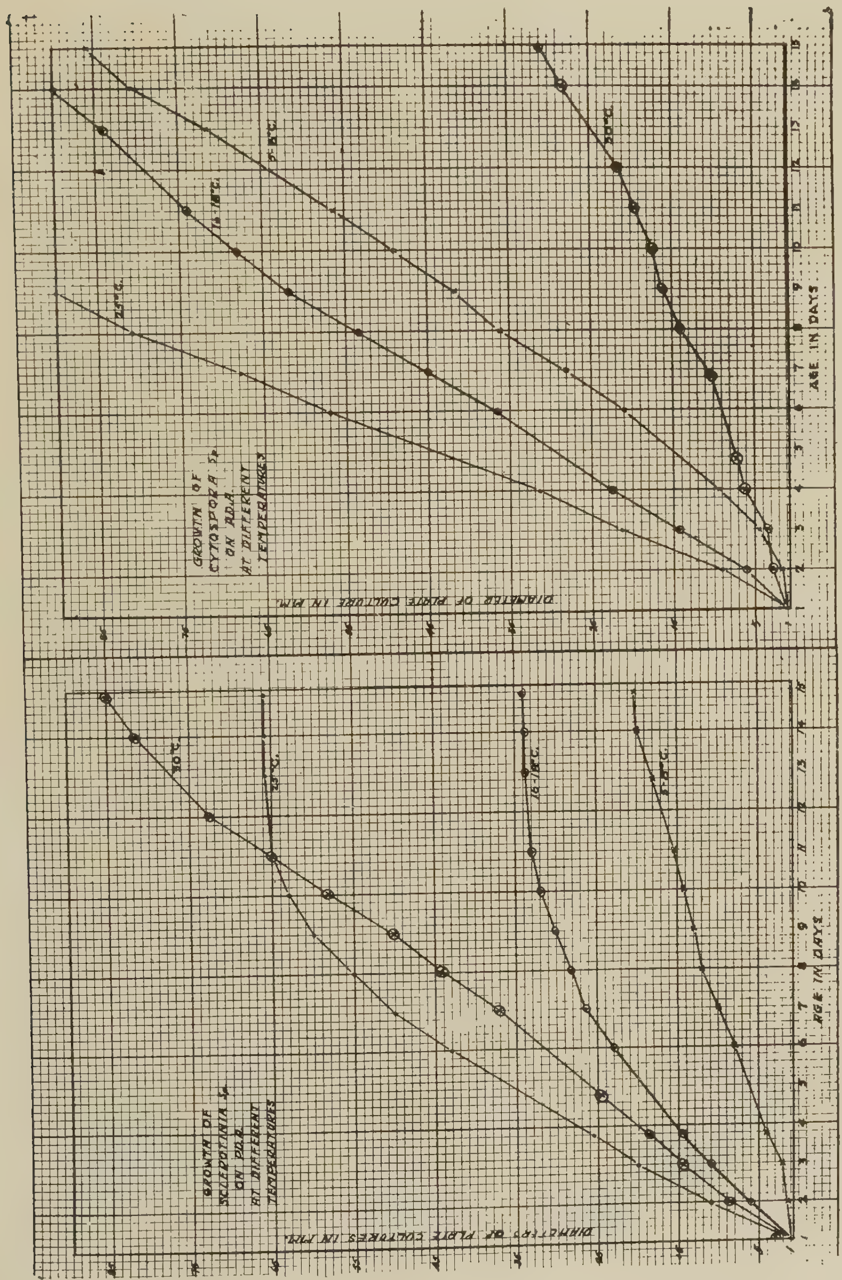
readily, first because *Cytospora* is capable of growing in cool weather (see text figure 5), secondly, because wounds do not dry out so rapidly in late fall and early spring when the average relative humidity is usually higher than in summer. Naturally this would favour incubation. In this connection, it is interesting to note that, though infection by inoculation is possible during the summer, the percentage is lower.

Discussion.

Obviously, *Cytospora* and *Sclerotinia* differ considerably in their behaviour and habits. The former is only weakly parasitic, is adapted to live in woody tissue and only rarely, if ever, occurs in the softer, more succulent tissue. The latter is an active parasite, thrives best in fruits, is able to grow very well on tender tissue, such as blossoms, and on occasion is quite capable of invading and killing the wood. The writer has been able repeatedly to isolate *Sclerotinia* from young cankers into which it has penetrated from "brown-rot" mummies left on the trees. The inoculations reported above also prove that it is able to live in wood. *Cytospora* can live and thrive in wound-gum-impregnated wood and carry on its invasion through the wound-gum "barrier" by penetration of wound-gum plugs. *Sclerotinia*, too, is able to penetrate individual plugs, but the "barier" eventually is effective against it and it can scarcely be said to thrive there. One reason for the difference in the behaviour of the two organisms is not far to seek. The wound-gum region is dry as compared with living wood and *Cytospora* seems to be able to withstand considerable drying and to grow well in a medium too dry for the steady growth of *Sclerotinia*. *Cytospora* is able to resist desiccation since successful transfers have been made with a small piece of aerial mycelium from a dry, eighteen-month-old wood block culture.

That *Sclerotinia* requires more moisture for rapid growth than *Cytospora* may be deduced from the growth rate curves for *Sclerotinia* and *Cytospora* (text figure 5). However, the fact that staling may also be a factor cannot be overlooked. At 25°C. the daily increase of *Sclerotinia* began to fall off steadily about the 7th day and after the eleventh day growth ceased. *Cytospora*, on the other hand, stopped growing only when it reached the edge of the plate (on the 9th day). At 16-18°C. the growth rate of *Sclerotinia* fell off markedly after the 10th day though it did not actually stop growing then, while *Cytospora* again, grew to the edge of the plate, though it showed a slight falling off after the 9th day. At 30°C. the *Sclerotinia* growth rate did not drop very much because twice as much agar was used and therefore the agar did not dry out so quickly. Of course, twice as much food material was also available. *Cytospora*, in spite of its advantage of more food and moisture did not grow any better at 30°C. than *Sclerotinia* at 5-8°C., indicating its characteristic as a low temperature organism.

It would appear that dryness and scarcity of easily available food, both of which conditions obtain in wound-gum regions, are probable factors in the respective abilities of *Sclerotinia* and *Cytospora* to thrive there. The very fact that *Cytospora* can make headway in such tissue, is, in itself, an argument that it can make use of foods there which are not easily available



Text figure 5: Growth curves of *Sclerotinia* and *Cytospora* at different temperatures, on potato dextrose agar.

to *Sclerotinia*. These phenomena open up a field in the physiology of fungi, the exploration of which time will not permit. Consequently at this juncture it must suffice to point out the probabilities rather than attempt to prove them.

Other means by which the wound-gum region would prevent the invasion of a fungus may be suggested. The transformation of food materials and protoplasm therein, into a substance toxic to the parasite is one. This is possible, but scarcely probable in the cases under consideration because both organisms are able to grow there to a greater or less extent, though it may well apply to other organisms in this or other hosts. The argument that the plugs occlude the vessels, cut off the supply of atmospheric oxygen from the tissues and thus render the tissue less penetrable has been advanced to uphold the idea of the protective nature of wound-gum. However, it is scarcely possible that the plugs render the tissue absolutely air tight, especially in view of the fact that bubbles of gas (not analysed, but presumably air, more or less modified by metabolic activities of fungus and host) are to be observed in wound-gum-impregnated tissue, freshly brought in and sectioned under water. These bubbles, if the sections are cut thick, are sometimes not all removed by the heating process used to hasten staining with cotton blue. Moreover *Cytospora* in liquid medium grows well submerged and *Sclerotinia* would not encounter a great deal of free air in the succulent tissues of the fruit in which it thrives. Thus it is reasonable to suppose that neither of these organisms would be greatly impeded by a scarcity of air or oxygen in the wound-gum region.

Another factor of major importance is the mere mechanical difficulty the mycelium encounters in penetrating the plugs of practically insoluble gum. That this difficulty may be overcome is shown by the frequent observation of hyphae penetrating or embedded in wound-gum in inoculations and elsewhere. Both organisms are capable of making their way through the occlusions. Plate figures 9-16 and 23-27 illustrate different stages of the process. Figures 7, 11 and 16 were taken from stubs inoculated with *Sclerotinia*, the remainder are from stubs invaded by *Cytospora*. Figures 6 and 24 show hyphae penetrating plugs which had probably formed shortly before pentration and were certainly not so hard as the rest, since the hyphae are not much constricted. Ordinarily the hyphae form appressoria at the surface of the plug and then gradually force into it very slender "penetration threads". On emergence, the threads enlarge once more to normal proportions and continue on their way (figures 11, 12, 13, 14, 25, 26, 27). Even thin plugs, (figure 25), if sufficiently hardened, cause a constriction in the hyphae. On the other hand, thin, soft plugs (figures 5 and 24) may be penetrated without the apparatus of appressoria and penetration threads.

To be assured that the penetration threads were actually mycelial in character and not merely cracks in the plug, they were carefully examined with an oil immersion objective and a 15-power ocular. At this magnification (figures 23-27) cross walls could be observed in many of the threads (figures 23, 24, 26). Connection with the appressoria was definitely confirmed and those threads parallel to the line of vision were seen to be circular in cross section. Cracks in the wound gum do occur (figures 4, 24,

27) but unlike the penetration threads they are neither circular in cross section nor stainable in cotton blue. These facts establish, beyond a reasonable doubt, the identity of the penetration threads as a part of the hyphal system.

In addition to actually forcing their way through wound-gum plugs hyphae frequently follow the line of least resistance and get past the plugs by the simple method of avoiding them. To do this, they enter the medullary system where they pass from one cell to another by way of the pits of the cell walls. Hyphae are also often seen in the wood-parenchyma cells and fibres. These fungi therefore, do not lack means of surmounting the difficulty of passing the wound-gum "barrier" provided they can also find nutrition in the wound-gum area and can endure its comparative dryness.

Inoculation of Sterile Wood Blocks

In order to confirm the observations regarding the ability of the fungus to penetrate the plugs and live in tissue rich in wound-gum, a number of stubs (see table 5) were cut on September 11, 1928, and left on the trees until October 26th. Wound-gum was already abundant to a depth of one-quarter inch in these by October 5th and to about one-half inch by October 26th. On the latter date the stubs, about one-half inch long, were brought into the laboratory and put in tubes on top of a wad of absorbent cotton. Distilled water was added and the blocks were sterilized for thirty minutes at 15 lbs. There was no evidence of fungous growth on these blocks (D 32) when not inoculated so that they can be taken as sterile. Similar blocks made from branches not previously injured were also sterilized at about the same time. In the latter, no wound-gum had formed, even after ten months so that it is safe to assume that any wound-gum plugs present in the former were there prior to sterilization. The plugs were not appreciably affected by the steam treatment. Any cells containing starch were stained a uniform blue in iodine, owing to the fact that the starch grains had gone into solution at the high temperature. A small amount of brown colouring matter and probably some of the soluble food material leached out into the cotton.

The blocks inoculated with *Cytospora* in a short time became covered with considerable aerial mycelium and pycnidia formed outside the bark and in the cotton. This was most probably due to the moisture of the cultures. *Sclerotinia* cultures, on the other hand, did not produce more than a sparse amount of aerial mycelium which also sporulated. Histological examinations at successive intervals revealed a slow but steady penetration of the blocks. At first *Sclerotinia* kept pace with *Cytospora* (D21, D31, D17, D27, D30, D24) but in the long run it failed to penetrate as far as the centre of the block (D29, D23). This is not surprising as the cultures became pretty well dried in the course of two or three months. But it is significant that both organisms formed appressoria and penetration threads and were able to penetrate the plugs.

In this connection it is of interest that successful transfers were made from the aerial mycelium of these *Cytospora* cultures eighteen months after inoculation while with one exception *Sclerotinia* failed to grow.

Table 5.—*Observations on inoculations of wood blocks, sterilized one-half hour at 15 lbs. D– stubs cut 11.9.28; removed and sterilized 26.10.28. Others cut 5.10.28 and sterilized 6.10.28.*

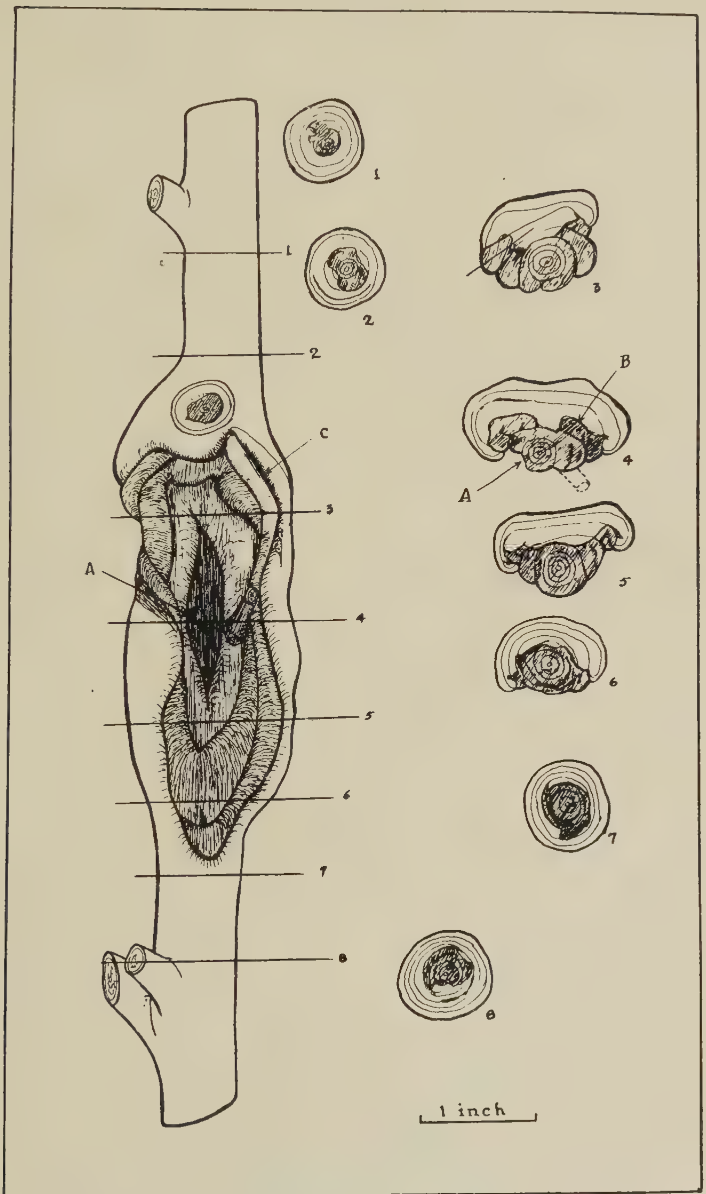
Number	Inoculation	Days from inoculation (or sterilization in case of checks) to examination	Depth of penetration of fungus	Wound-gum plugs	Penetration of plugs by fungus
D21	Cytospora	20	± 1/8″	+	+
D27	Sclerotinia	20	± 1/8″	+	+
D31	Cytospora	65	± ¼″	+	+
D30	Sclerotinia	65	± ¼″	+	+
D32	Check	66	—	+	—
1	Check	89	—	—	—
2	Cytospora	89	Throughout block	—	—
D17	Cytospora	147	Almost throughout block	+	+
D24	Sclerotinia	147	Almost throughout block	+	+
D29	Cytospora	268	Throughout block	+	+
D23	Sclerotinia	268	Nearly throughout block, but most at ends and bark	+	+
3	Cytospora	139	Throughout block	—	—

This is a further indication that *Sclerotinia* is less able than *Cytospora* to survive drying.

Evidence from Cankers

Observations of many peach cankers confirm the view that *Cytospora* is able to grow in the wound-gum region much more successfully than *Sclerotinia*. A large number of incipient cankers were found at the base of pedicels of fruit affected by brown-rot. In some cases the fruit had been removed in the fall, in others the mummies had remained on the tree throughout the winter. In both, where the mummies, when present, did not touch the twig, the mycelium had travelled down the pedicel and invaded the branch; in the latter, where the mummy was in contact with the branch, necrotic areas appeared in the wood and bark, and mycelium had passed directly from fruit to branch. From such cankers *Sclerotinia* was isolated. Frequently, the wood invaded by *Sclerotinia* had no wound-gum plugs, but the surrounding wood was heavily impregnated.

Several times in cankers, one and two years old, the fruit pedicel was still present, surrounded by a necrotic area and the callus of the next season's growth. Sometimes the callus itself was dying at the edges. Isolations from the brown wood underlying the callus yielded *Cytospora*, though obviously the canker had been initiated by the action of *Sclerotinia*.



Text figure 6: Typical canker, with cross sections at various levels, to show extent of browning. For explanation see text.

Text figure 6 illustrates a typical canker. The point of origin of the canker is obviously at A. As the appendage once attached at that point had fallen off it was impossible to say whether it was a fruit pedicel or a small twig. Regardless of which it might be, the organism isolated proved to be *Cytospora.* Histological examination revealed no fungus in the wood yet alive but considerable in the brown regions well below 7 and above 2. Between the living and dead wood there was a thin, dark zone, B, more highly impregnated with wound-gum than the rest of the brown region. This zone seems to be partially protective in that the progress of the fungus is slow radially and tangentially. At the same time, the fungus has contrived to kill four calluses and has begun on the fifth at C and has spread for several inches longitudinally.

A frequently observed method of invasion by *Cytospora* is shown in diagrams 'g' and 'h', text figure 4. A pruning stub is attacked, the healthy lateral is gradually encircled, and the canker continues to spread up the lateral and down the larger branch. All the while, the border of the wound-gum zone is in advance of the fungus.

The canker illustrated in text figure 7 developed from a twig killed by "die-back". The pycnidia of *Cytospora* can be seen on the bark in the upper part of the photograph. During the winter the lesion had spread on the large branch, from above the lower lateral to just below it (C). Judging by the internal appearance the canker had in the fall of 1929 made

Text figure 7: Young canker, originating from a twig killed by "die-back". Photographed April 15, 1930.

its way about an inch up the lateral on the upper side to A, and, since then had completely girdled it and spread to B. The organism was observed in and isolated from the dead base of the lateral near A.

In the cankers, as well as in the inoculations, the penetration of wound-gum plugs by hyphae by means of appressoria and penetration threads were very often seen.

To sum up, the significant facts arising out of the study of the cankers are these. First, *Sclerotinia* dies out in a canker in which *Cytospora* grows on; secondly, the presence of wound-gum does not prevent the invasion of the wood by *Cytospora*, and thirdly, though confined to the wound-gum region, *Cytospora* is able to extend the boundaries of the lesion. Some evidence has already been brought forward to show that *Cytospora* is able to kill tissues and thus bring about wound-gum formation in advance of its invasion.

Summary and Conclusions

1. When the parenchymatous cells of wood or bark die under certain conditions of moisture and temperature, their contents become transformed into yellowish or brownish decomposition products, more or less resistant to solvents.

2. If the cells dry out rapidly, less brown material is formed than if they die under moist conditions. If starch is present, it does not disappear under the former conditions.

3. In the peach the decomposition products ooze out into the vessels forming wound-gum plugs, colourless at first but later becoming yellow. The plugs become lignified, especially on the border between living and dead wood. Wound-gum is not soluble in hot or cold water and does not even swell.

4. In the grape wound-gum plugs are not formed in vessels, probably because the latter are already filled with a jelly-like substance, formed from the sap. This jelly swells and is partially, if not completely, soluble in water. When permeated with mycelium of *Cryptosporella*, the jelly sometimes becomes yellow and resembles wound-gum.

5. In the peach injured meristematic tissue during the period of activity forms gum-lacunae due to the dissolution of the middle lamellae. These pockets become filled with gum produced by pectic substances and by the disorganization of cell contents. If exuded, this gum apparently undergoes no further change and remains partly water-soluble and capable of swelling in water. If the gum becomes embedded in the wood, as frequently happens, it takes on the characteristics of wound-gum and is often partly or wholly impregnated with lignin.

6. The browned tissue in grape wood, due to the presence of the above mentioned decomposition-products, does not prevent the invasion of the wood by *Cryptosporella viticola*, when there is sufficient moisture for the germination of spores.

7. Hyphae of *Cytospora* and *Sclerotinia* are able to penetrate wound-gum plugs in peach wood by means of appressoria and slender penetration threads. In nature *Sclerotinia* is found in the wound-gum region but is

unable to survive for long, probably because of lack of moisture. *Cytospora*, on the other hand, lives on from year to year in the wood impregnated with wound-gum.

8. When a wound is infected with *Cytospora*, the wound-gum region is usually much more extensive than in an uninfected wound.

9. There is some evidence that *Cytospora* and *Sclerotinia* secrete a toxic substance which kills the wood and promotes the formation of wound-gum.

10. The presence of wound-gum in peach wood may slow down the rate of invasion of *Cytospora* but does not prevent it. On the other hand it seems to stop *Sclerotinia*.

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DESCRIPTION OF PLATES

All drawings were done with the aid of a camera lucida. Figures 1-10 were made with a Watson microscope, one-sixth inch objective and either a 6X or 10X ocular. For figures 17-22, a Spencer microscope was used with 4 or 16 mm. objective and 6X or 10X ocular. A Zeiss microscope was employed for drawings 22-26, with oil-immersion objective and 15X eye-piece. All the illustrations relate to peach wood. Cotton-blue in lacto-phenol was used to stain the mycelium, and iodine-chloral-hydrate for the determination of starch.

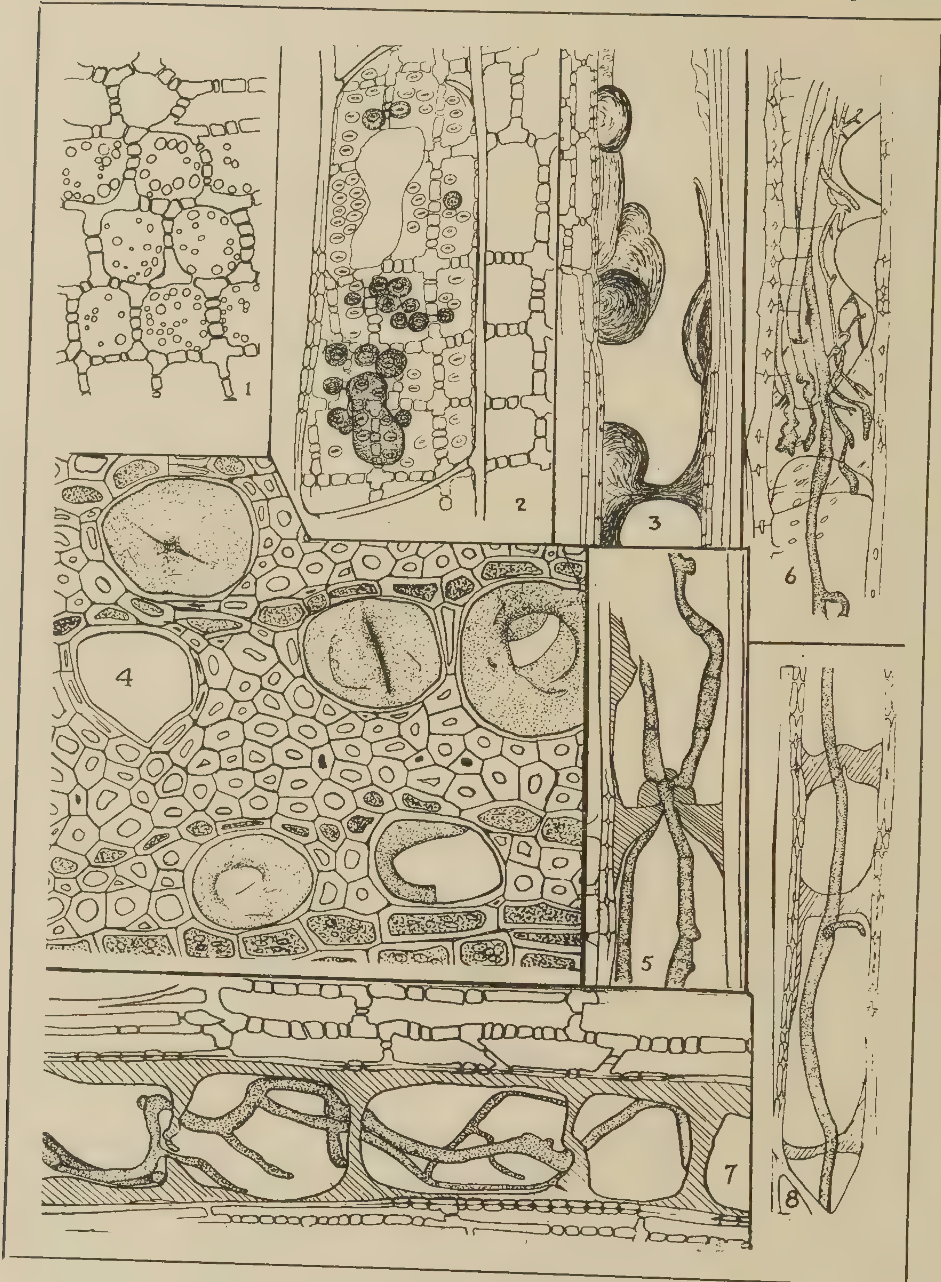

PLATE I.

1. Medullary ray cells containing the globules of yellowish material which replace the starch grains shortly after wounding. Section mounted in iodine-chloral hydrate.
2. Vessel adjacent to medullary ray and containing globules of gum which overlie the pits in the walls.
3. Vessel containing larger globules of gum, which are coalescing to form plugs.
4. Transverse section showing wound-gum plugs more or less completely occluding the vessels.

5, 7, 8. Mycelium pushing its way through thin plugs. 5 and 8 are *Cytospora;* 7 is *Sclerotinia.*

6. Irregular hyphal penetration of plugs by *Cytospora.*

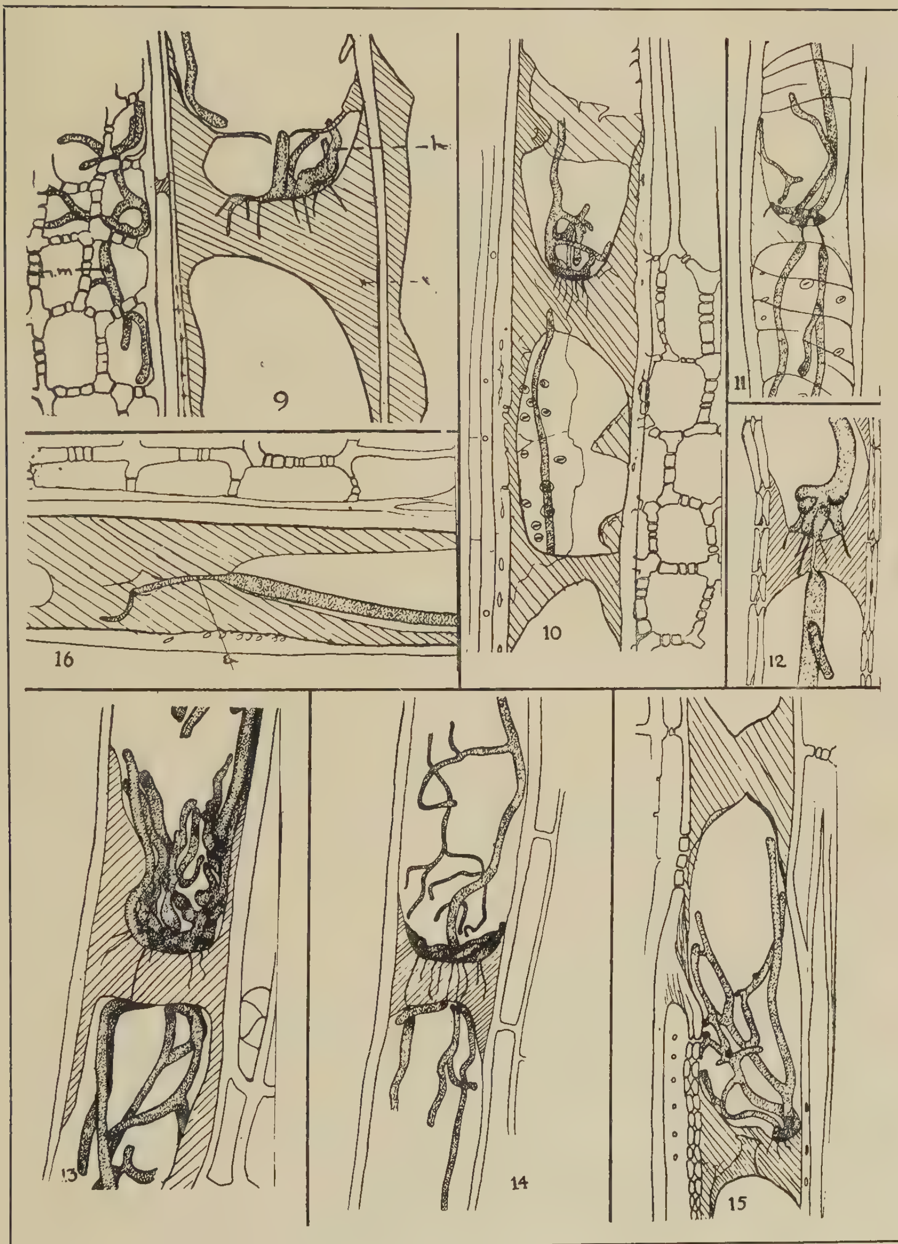

PLATE II.

9, 10, 12, 13, 14, 15. Pentration threads and appressoria of *Cytospora.* 10 and 15 were from wood-block pure cultures. (Table 5).

11. Penetration threads of *Sclerotinia.*

16. *Sclerotinia* hyphae entering wound-gum plug in heartwood by way of a crack and then pushing its way on by means of a penetration thread. One week after cutting and inoculation.

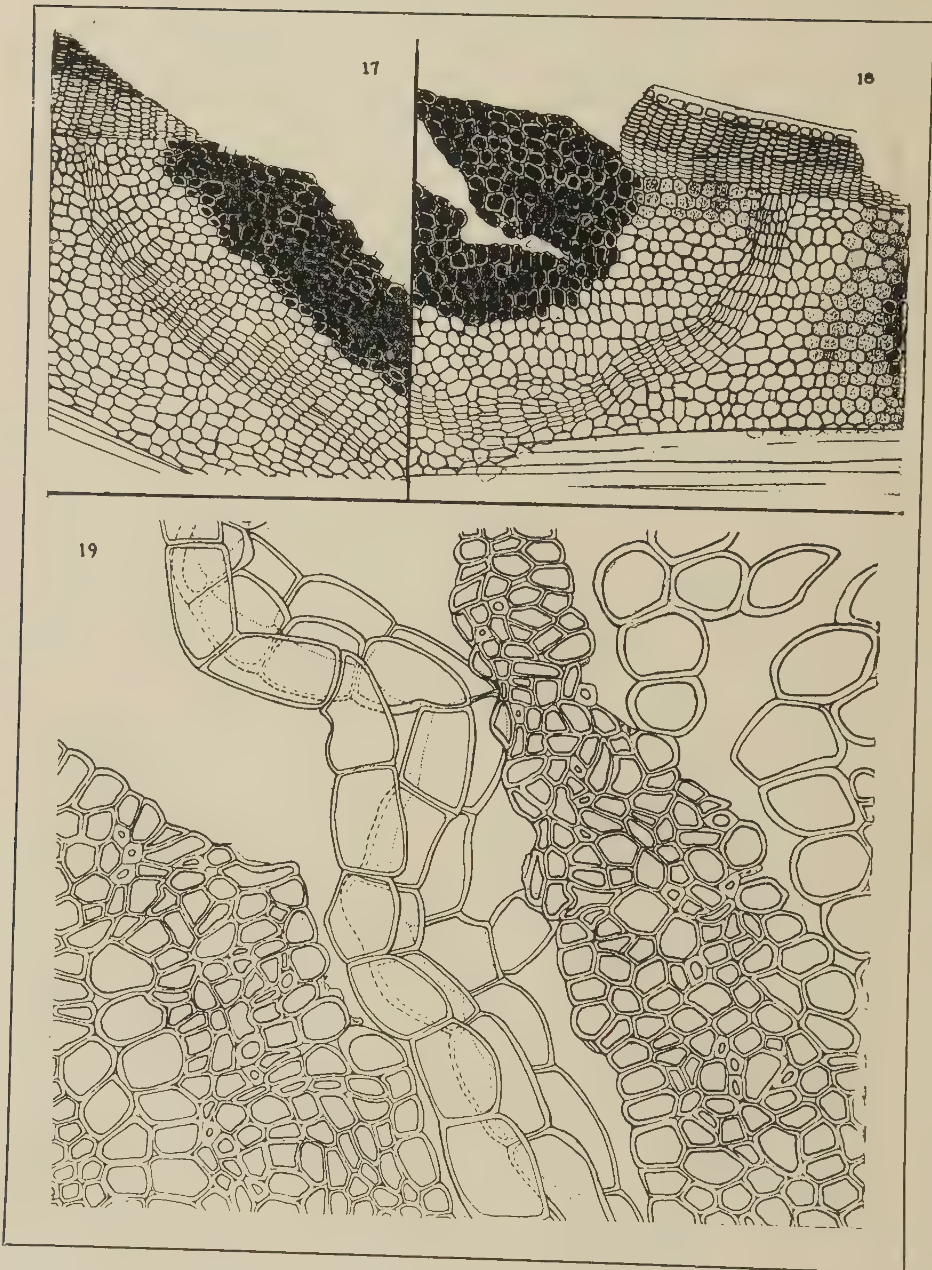

PLATE III.

The sections from which plates III and IV were made, were mounted in iodine-chloral-hydrate.

17. Shallow bark injury covered by grafting wax. Drawing made two weeks after wounding.
18. Shallow bark injury of same age as that shown in 17, not covered by wax. Notice that the dry, starch filled region at the centre of the injury, and the yellow starchless dead zone between it and the wound periderm are larger in the uncovered wound.
19. Cross-section through a gum-pocket in the phloem.

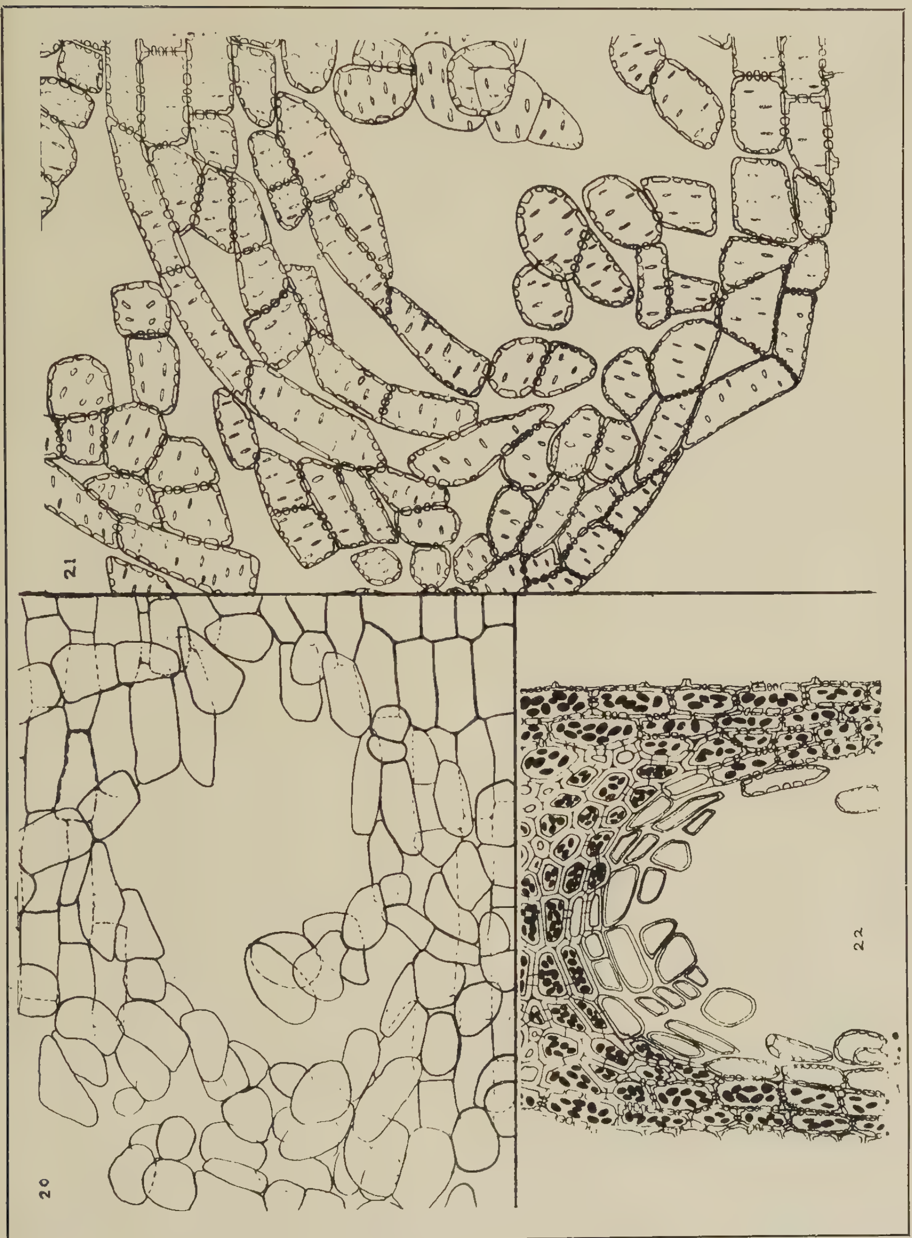

PLATE IV.

20, 21. Radial sections through a gum-pocket in xylem near the cambium. Note the loose-lying cells. They were embedded in a colourless or slightly yellow gum.

22. Transverse section through gum-pocket in xylem. The cells of the disorganized tissue contains no starch.

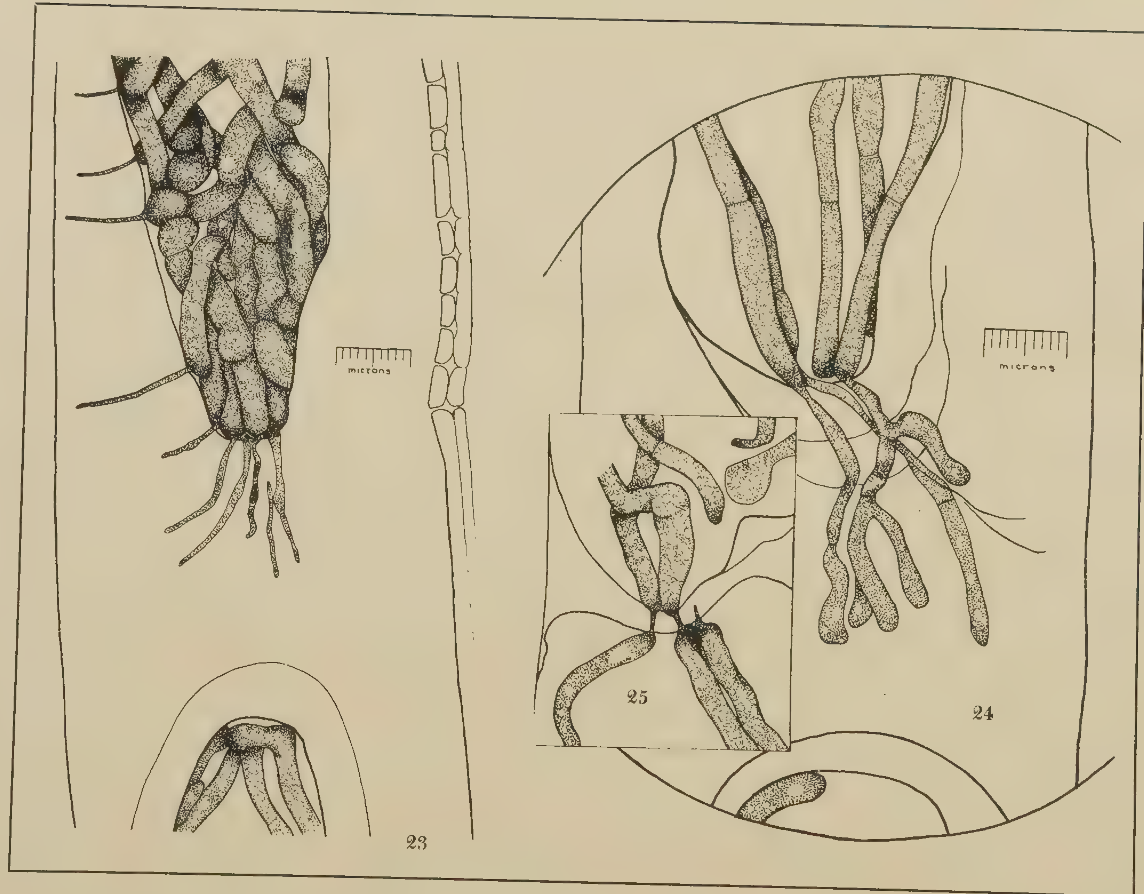

PLATE V.

23. Appressoria and penetration of *Cytospora*. Note the cross walls in the threads.
24. *Cytospora* mycelium penetrating a young and presumably soft plug. The constrictions are only slight.
25. *Cytospora* hyphae penetrating thin hard plug. Observe hyphae regain normal size on emergence.

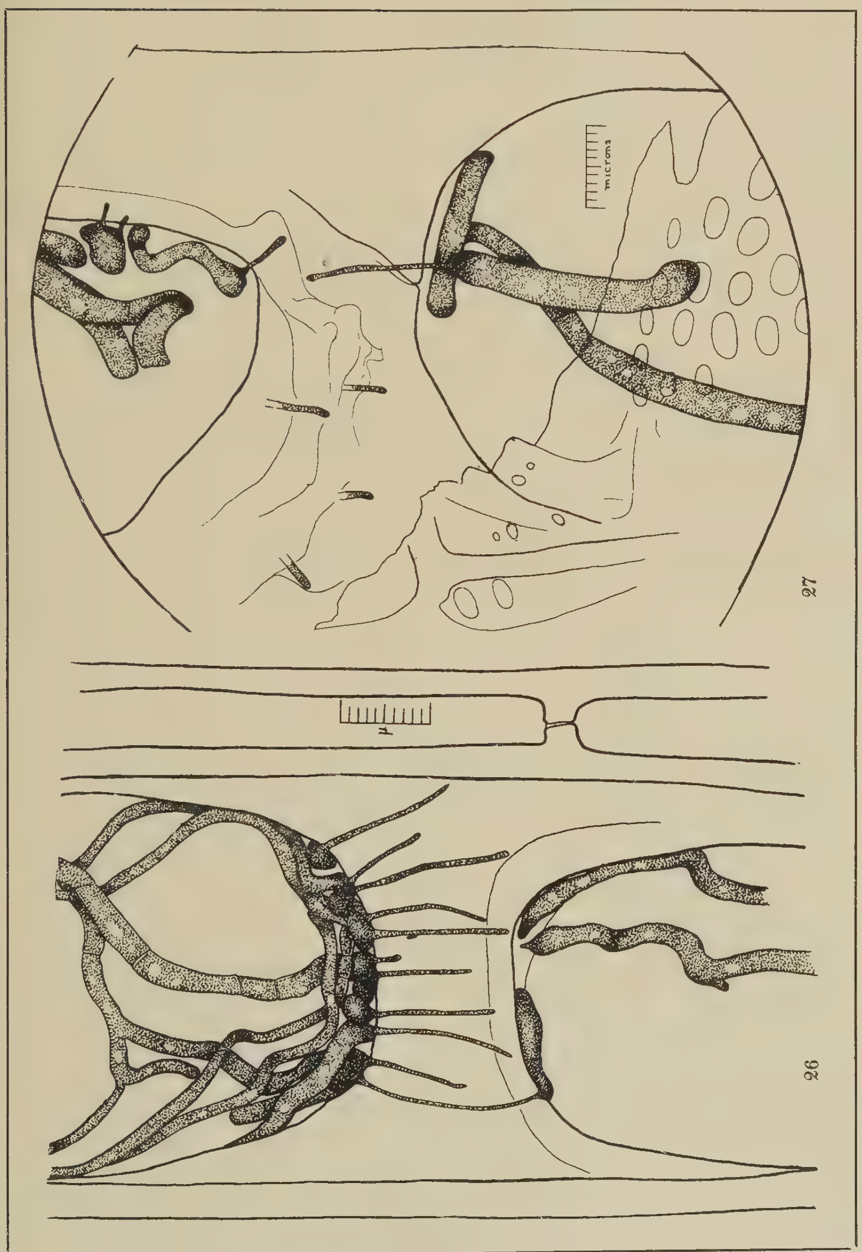

PLATE VI.

26. Wound-gum plug completely penetrated by a penetration thread. A number of other threads are about to emerge. Cross walls observable in some threads.

27. The hypha below has emerged from the plug, but, in the process of sectioning has been separated from the appressorium. Note the remains of tips of penetration threads on the left hand side of the plug.

LIFE-HISTORY AND HABITS OF THE THREE-LINED LEAF ROLLER, *Pandemis limitata* Rob., IN NOVA SCOTIA.

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[Received for publication October 9, 1931]

In 1926, the larvae of an unknown species of insect attracted considerable attention in a few orchards in the Annapolis valley. This was largely due to its habit of tying leaves to the fruit and producing a definite type of scar upon the surface of the apple. The insect was most prevalent in the Berwick and Lakeville districts during the summer of 1926. In the succeeding three years, however, adults and larvae have been taken in many localities and apparently, therefore, the species is well distributed over the entire Annapolis valley. The adults resemble the more common species "The Oblique-banded Leaf Roller," *Archips rosaceana* Harris, in size and colour, and for a time the writer wondered whether they were not diffused forms of this species. Adults forwarded to Ottawa, in 1927, were identified by Dr. J. H. McDunnough as *Pandemis limitata* Rob. This appears to be the first report of this species in Nova Scotia orchards.

There are three fine, rather pale, oblique lines across the fore wings of the adults, and the larvae, like many of the species belonging to the family Tortricidae, are typical so-called "leaf rollers." As a suitable common name for this species "The Three-lined Leaf Roller," is, therefore, proposed.

Life History and Habits

General. There is only one generation each year of *Pandemis limitata* Rob. in Nova Scotia. The winter is passed as fourth instar larvae upon the smaller limbs of the trees in the orchard in a hibernaculum. When the buds begin to swell in the spring the larvae emerge and feed upon the interior of the buds and later draw the leaves together in a manner typical of leaf rollers. The larvae become mature the latter part of June and pupate among the foliage of the trees. The majority of the adults emerge during July and in a few days eggs are deposited upon the upper surface of the leaves. The young larvae appear upon the foliage of the trees the latter part of July and early August to complete part of their growth before hibernating for the winter. These larvae only feed for a period of about three weeks when they desert the foliage, and the winter quarters are soon constructed.

Overwintering Larvae. The larvae of *Pandemis limitata* Rob. as they emerge from their hibernacula are very small, being only about one-eighth of an inch in length. The body is of a dirty yellow colour with a tinge of green; head black; tubercles prominent, tipped darker than body.

Emergence is somewhat later in the spring than with most budmoths found in the Annapolis valley that pass the winter in a hibernaculum. It is from one to two weeks later than our more common budmoth, *Spilonota ocellana* D. & S. In 1927, the larvae began to appear upon the buds on May 9, but at the insectary none emerged until May 16. In 1926, the first observed was on May 5, and in 1929 on May 4. The emergence is

spread over a period of about two weeks, but this depends largely upon how rapidly the weather warms up at this time, for with three or four consecutive warm days the larger number become active and find their way to the buds. For some little time previous to emerging, the larvae become semi-active at the warmest part of the day and thin the hibernacula from the inside. As a result they are prepared to issue forth to feed upon the buds as soon as the temperature and bud development become favorable. Upon emerging they at once eat their way into the buds, usually at the tips where the green is exposed. They may, however, enter from the side by gnawing through the harder bud scales. The larvae, therefore, at this period are typical budmoths. After the trees come to full leaf the foliage is drawn together in the familiar tortricid manner. They feed upon the tied-together leaves at the margins, but strangely, only a portion is consumed when they crawl to others near at

TABLE 1.—*Length of instars of overwintering larvae of Pandemis limitata Rob., 1927.*

Record No.	Date larvae emerged from hiberna-culum	Date 1st moult	Date 2nd moult	Date 3rd moult	Date larva pupated	Length of feeding period after hibernation	Date adult emerged	Length pupal period
1	May 16	May 31	June 10	June 21	July 3	48 days	July 16	13 days
2	" 16	" 31	" 10	....	June 27	42 "	" 11	14 "
5	" 16	June 7	" 18	June 27	July 9	54 "	" 22	13 "
7	" 16	" 6	" 18	" 27	" 8	53 "	" 22	14 "
8	" 16	" 6	" 14	" 21	" 2	47 "	" 14	12 "
11	" 16	" 7	" 18	" 27	" 10	55 "	" 23	13 "
13	" 10	missed	" 6	" 18	June 29	50 "	" 13	14 "
14	" 14	June 10	" 21	" 29	July 12	59 "	" 25	13 "
15	" 9	May 20	" 10	....	June 27	49 "	" 12	15 "
16	missed	missed	" 9	....	" 24	....	" 8	14 "
18	"	"	" 11	....	" 27	....	" 11	14 "
21	May 15	June 2	" 18	June 28	July 12	58 days	" 26	14 "
22	missed	missed	" 5	" 21	" 3	....	" 15	12 "
31	"	"	" 15	....	June 27	....	" 13	16 "

TABLE 2.—*Head widths of instars of overwintering larvae of Pandemis limitata Rob., 1927.*

Record No.	Head width of hibernating larva	Head width after 1st spring moult	Head width after 2nd spring moult	Head width after 3rd spring moult	Sex of pupa
1	.437	.648	1.090	1.729	♀
2	.579	.938	1.542		♂
5	.567	.842	1.154	1.707	♀
7	.421	.623	1.045	1.646	♀
8	.518	.799	1.173	1.770	♀
11	.461	.712	1.093	1.707	♀
13	.491	.729	1.103	1.687	♀
14	.576	.864	1.193	1.810	♀
15	.550	.864	1.523		♂
16	..	..	1.440		♂
18	..	..	1.430		♂
21	.576	.946	1.173	1.720	♂
22	..	.864	..	1.811	♀
31	..	.752	1.523		♂

TABLE 3.—*Length of instars of overwintering larvae of Pandemis limitata Rob., 1929*

Record No.	Date larvae emerged from hibernaculum	Date 1st moult	Date 2nd moult	Date 3rd moult	Date larva pupated	Total length feeding period in spring	Date adult emerged	Length pupal period
2	May 7	May 31	died on June 8					
3	7	" 27	June 5	....	June 18	42 days	July 3	15 days
4	" 7	" 27	" 8	....	" 22	46 "	" 5	13 "
5	" 7	" 27	" 4	June 14	" 24	48 "	" 10	16 "
6	" 7	" 27	" 8	....	" 24	48 Adult failed to emerge		
7	" 7	" 31	" 11	June 18	" 26	50 "	July 12	16 "
9	" 7	" 31	" 11	" 18	July 2	56 "	" 15	13 "
10	" 7	" 27	" 8	died				
11	" 7	" 27	" 8	June 28	July 16	70 "	Aug. 1	16 "
13	" 7	" 31	" 8	" 18	June 27	51 "	July 12	15 "
14	" 7	" 31	" 11	....	" 24	48 "	" 8	12 "
15	" 7	" 27	" 8	....	" 22	46 "	" 8	16 "
16	" 7	" 27	" 4	June 14	" 24	48 "	" 10	16 "
17	" 7	" 31	" 8	" 18	" 27	51 "	" 13	16 "
18	" 7	" 31	" 11	....	" 24	48 "	" 8	14 "
19	" 7	" 27	" 8	....	" 22	46 "	" 6	14 "
22	" 7	" 31	" 8	June 14	" 25	49 "	" 10	15 "
23	" 7	" 31	" 11	" 18	" 27	51 "	" 12	15 "
24	" 7	" 31	" 14	....	" 27	51 "	" 11	14 "
25	" 7	" 31	died on	June 14				
26	" 7	missed	June 18	died on June 24		48 "		
27	" 7	May 30	" 14	June 28	July 5	59 "	July 20	15 "

hand and likewise draw them together with silk, so that the necessary protection may be obtained. When these shelters are in proximity to newly formed fruit the larvae feed upon the surface of the apple causing deep excavations. The larvae are sensitive to disturbance and readily drop from the trees.

The mature larvae are nearly an inch in length, head light amber or pale green in colour, with body entirely green. The rows of tubercles each side of the dorsal line of the mature larvae are slightly lighter in colour than the surrounding body surface. This, although not pronounced, is usually sufficient to determine the larvae from those of other species belonging to this group, some of which may be present in the orchard at the same time. The larvae become mature the latter part of June and early July when pupation takes place among the tied-together leaves upon the trees.

From the result of the rearing work in both 1927 and 1929, it is shown in tables 1, 2, 3, and 4 that part of the larvae moulted three times in the spring while there were others that moulted only twice. There is, therefore, a total of either six or seven instars. In tables 2 and 4 the head widths are computed in millimeters.

The total length of the feeding period of the over-wintering larvae in 1927 was 42 to 59 days, and 42 to 70 days in 1929, this period including the latter portion of May, the greater part of June, and in a few instances the early part of July. There was a pre-pupal period of two to four days included as part of the feeding period, which is not indicated separately in the tables.

TABLE 4.—*Head widths of instars of overwintering larvae of Pandemis limitata Rob., 1929*

Record No.	Head width of hibernating larva	Head width after 1st spring moult	Head width after 2nd spring moult	Head width after 3rd spring moult	Sex of pupa
2	.578	.741	died		
3	.518	.885	1.585		♀
4	.567	.864	1.399		♂
5	.453	.720	1.029	1.543	♂
6	.502	.793	1.358	died	
7	.502	.781	1.152	1.688	♂
9	.440	.617	1.029	1.646	♀
10	.469	.864	1.379	died	
11	.453	.699	1.070	1.379	♂
13	.514	.741	1.132	1.708	♀
14	.555	.885	1.605		♀
15	missed	.777	1.441		♂
16	"	.761	1.152	1.700	♀
17	.494	.679	1.029	1.605	♂
18	.554	.864	1.482		♂
19	.502	.823	1.441		♂
22	.514	.720	1.091	1.667	♂
23	.514	.864	1.317		♀
24	.534	.864	1.399		♂
25	.494	died			
26	missed	.964	1.358	died	
27	"	.699	1.111	1.688	♀

Pupae. The pupae are slightly less than one-half an inch in length; green when first formed, soon turning brown. There is only slight protection provided for the pupa. In some instances they are enveloped in a thin silky covering, but frequently are retained among the partly eaten rolled leaves on the tree with a few threads of silk wound around the caudal hooks.

The majority of the larvae pupate late in June and early in July. In 1927, pupation began at Annapolis Royal on June 24 and was complete on July 14. In the following year, the first pupa was found outside on June 20, but mature larvae were common until the end of the month, after which they rapidly diminished. The season of 1929 was somewhat earlier and larvae began to pupate June 16, with the majority pupating the last week of June and the first week of July. Every year an occasional larva was found in the orchard until about August 1. In 1929, one belated larva was observed at Annapolis Royal outside as late as August 12, which pupated on the following day. The adult from this pupa emerged on August 24. This was by far the latest seasonal record during the past three years. The pupal period lasts from 12 to 16 days.

Adults. The adults are of a cinnamon-brown colour, with three fine, pale oblique lines across the fore-wings. When spread, the adults vary in width from slightly less than three-quarters of an inch to one inch, the males as a rule being the smaller.

The seasonal variation of adult emergence from year to year is not great. The first adult emerged in 1927 on July 7 and the last on July 26, the maximum occurring from July 10 to 20. The season of 1928 was somewhat earlier and adult emergence began on July 3 and continued until

July 31, with the maximum about July 9 to 18. In 1929, the first adult appeared on July 3 and the last on July 20 (omitting the belated female emerging on August 24 already mentioned) with the maximum near the middle of July.

Egg-laying records were obtained by using lantern globe cages within which a male and female were confined immediately upon emerging. A number of the females failed to oviposit and at least in 1929 the majority failed to deposit their full complement of eggs, as a number were found in the ovaries at death. In 1927, the females were not examined after ovipositing. Copulation and egg-laying apparently always took place during the night. The females began to oviposit 3 to 5 days after emerging, the eggs being laid in masses. The first mass deposited was usually the largest, containing 100 to 175 eggs, followed by others of one-half or less in number. In confinement not more than one mass was deposited in one night.

The adults in the orchard are usually found at rest upon the foliage of the trees and fly short distances in a zigzag course when disturbed and come to rest again upon a near-by tree or on the ground. At early evening they were more active, but various types of light in the orchard failed to attract them. Tables 5 and 6 are the egg-laying records for 1927 and 1929. The signs ♀, ♂, on the left in the tables indicate when the females and males emerged and were placed in the cages; those on the right when they died. The figures under the respective dates indicate the number of eggs in the mass.

As no attempt was made in 1927 to dissect the females after ovipositing in the cages, the egg-laying results obtained in 1929 are probably more accurate. Considering only 1929 records, therefore, there was per individual an average of 144 eggs deposited and an additional 65 left in the ovaries. Therefore, the total average capacity in 1929 was 209 eggs for each female. The average number of days that the females and males lived in the cages both in 1927 and 1929 was approximately 9 and 8 days respectively.

Eggs. In the orchard the eggs were laid in flat masses on the upper surface of the leaves, the eggs overlapping each other in the mass. In colour they are yellowish-green becoming somewhat duller and darker as hatching approaches. The egg masses blend in colour with the foliage and are, therefore, difficult to find.

The majority of the eggs are deposited during the month of July, the maximum from July 10 to 20. The incubation period as given in tables 7 and 8 indicate that this varied from 10 to 13 days in 1927 and 11 to 15 days in 1929. Hatching always occurred in the early morning, usually between 7 and 8 o'clock, with all the larvae escaping from the mass in a comparatively short time, rarely exceeding one hour. The empty mass is like a white scale on the leaf, and is soon dislodged by wind or rain.

Summer Brood Larvae. The summer brood larvae begin to appear in the orchard about or just after the middle of July. As the adult emergence is prolonged the hatching period is also prolonged correspondingly, and

Table 5.—*Egg-laying records of adults of Pandemis limitata Rob., 1927*

Record No.	JULY																			Number of eggs
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	♀	♂						♂				♀		no eggs						0
2	♀	♂					176	64	♂	♀										240
3	♀				♂		15	⚥		eggs unfertile										15
4	♀	♂									♀		♂		no eggs					0
5					⚥							♀			♂		no eggs			0
6						⚥			168							♀	♂			168
7						⚥			167			65				♂		♀		232
8						⚥			73	41		36		45	♀	♂				195
9								⚥			112		66						⚥	178
10									⚥					♀		♂	no eggs			0
11									⚥									⚥	no eggs	0
12												♀	♂			97	21		⚥	118

Table 6.—*Egg laying records of adults of Pandemis limitata Rob., 1929.*

Record No.	JULY																			No. of eggs laid	No. of eggs in ovaries	Total No. of eggs
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
1	♀		♂								♂		♀							0	206	206
2				⚥				154						♂	♀					154	122	276
3						⚥		158	♂					♀						158	61	219
4						⚥			126				♂			♀				126	23	149
5								⚥						85	92	30	♂	♀		207	23	230
6									♂	♀				131	29		⚥			160	66	226
7									♂	♀					182	♂		♀		182	0	182
8								♂					♀		101		62	♂	♀	163	21	184

TABLE 7.—*Incubation period of eggs in 1927.*

No. of cage	Date eggs laid	Date eggs hatched	Number eggs in mass	Length of incubation period
2	July 13	July 23	176	10 days
2	" 14	" 25	64	11 "
6	" 15	" 26	168	11 "
8	" 15	" 27	73	12 "
8	" 16	" 28	41	12 "
8	" 18	" 31	36	13 "
9	" 17	" 31	112	13 "
12	" 20	Aug. 1	97	12 "

TABLE 8.—*Incubation period of eggs in 1929.*

No. of cage	Date eggs laid	Date eggs hatched	Number eggs in mass	Length of incubation period
2	July 10	July 22	154	12 days
4	" 11	" 24	126	13 "
3	" 10	" 25	158	15 "
5	" 16	" 28	85	12 "
5	" 17	" 28	92	11 "
6	" 16	" 28	131	12 "
7	" 17	" 29	182	12 "
8	" 17	" 30	101	13 "
8	" 19	Aug. 1	62	13 "

they continue to emerge for the remainder of the month and the greater part of August. In 1926, hatching was noticed as late as September 2, but the spring of 1926 was late and the season throughout was backward. In most seasons the maximum number hatch during the last week of July and the first week of August.

The larvae when hatched are of a pale yellowish-white colour and hardly one-sixteenth of an inch in length. Upon escaping from the egg mass they crawl at once to the edge of the leaf and soon drop therefrom, suspended by silken threads. By this means together with the aid of winds, the larvae are not only distributed uniformly over the trees, but may be carried for some distance. The larvae, in common with other species of this group, seek some shelter upon the trees apparently for protection. This protection usually consists of foliage which has been previously tied or bunched together by another species feeding earlier in the season. With *Pandemis limitata* Rob., the larvae continue to spin down from leaf to leaf until some such shelter is finally located, otherwise the majority apparently perish by ultimately dropping to the ground. The shelters of the eye-spotted budmoth, *Spilonota ocellana* D. & S., are deserted in June. These consist of partly chewed leaf or blossom clusters tied together in small bunches. In Nova Scotia these bunches remain upon the trees for some time and provide the necessary shelter for the newly hatched larvae of *Pandemis limitata* Rob. Frequently as many as eight or ten larvae have been found in one of these deserted shelters. They eat small portions of the at-

tached leaves, and at every favorable opportunity feed upon the fruit as well. There is a tendency for the larvae to scatter after the first moult, when they appear somewhat more capable of providing for their own protection. At this time the larvae frequently tie a leaf to the side of the apple, when further damage is done to the fruit.

The larvae feed for approximately three weeks, when they desert the foliage and begin to construct hibernacula. During this time they moult twice in their feeding shelters, the third moult occurring after the hibernaculum is partly constructed, the cast head being found between the layers of silk. The winter is, therefore, passed in the fourth instar. The hibernacula are constructed under old bud scales, in the angle between the bud and twigs, and in small depressions on the small outer limbs. They are covered with fine pellets of frass, and appear from the exterior very much like those spun by *Spilonota ocellana* D. & S. After the outer portion is constructed the larva moults and then spins a very delicate, almost pure white case about itself. This fits almost like a glove about the larva and is readily separated from the outer portion of the hibernaculum. The more advanced larvae begin to hibernate about the middle of August, the remainder commencing hibernation during a period up to the first part of September.

In the insectary larvae were reared in individual glass vials and fed upon apple leaves. For the most part feeding and development were normal. There were two moults, and after feeding about 6 to 8 days in the third instar, they deserted the food and wandered about the vials endeavoring to escape. They were at once removed and placed on individual apple seedlings with a band of tanglefoot at the base to prevent their escape. Within a few hours nearly all started to spin hibernacula. When these were examined in December, the cast head was found between the layers of silk, the hibernaculum being about one-half constructed when moulting occurred. Measurements were made of head widths and, also, as far as possible of the cast head, but the latter was frequently broken or distorted. The results are shown in tables 9 and 10. The ratio of head width between the third and hibernating instar is not as great as between the other instars.

There is one peculiarity regarding the larvae to be recorded. The colour of the head throughout the entire larval period is light amber or pale green, with the exception of the hibernating instar when the head is black. During the first year's work with the insect, the finding of black-headed larvae, from reared material, in the hibernacula, led the writer for a time to consider that another species had crept in unobserved.

Injury Caused. There are three types of injury to be recorded. (1) Bud injury in the spring. (2) Damage to the newly formed fruit by the over-wintering larvae. (3) Side injury to the fruit by the summer brood. As the larvae feed upon the buds before they are completely opened, there follows a certain amount of injury in the spring. Evidently a considerable degree of infestation must be present for pronounced injury of this type to

TABLE 9.—*Length of larval instars of Pandemis limitata Rob., previous to hibernating, 1929.*

No.	Hatched	1st moult	2nd moult	Hibernating
1	July 22	July 28	Aug. 9	Aug. 17
2	" 22	" 28	" 5	" 12
3	" 22	" 28	" 9	" 15
4	" 22	" 28	" 5	" 14
6	" 22	" 28	" 5	" 12
7	" 22	" 28	" 9	....
9	" 22	" 28	" 5	Aug. 12
10	" 22	" 28	" 5	" 19
11	" 22	" 28	" 12	" 15
12	" 22	" 28	" 9	" 14
13	" 22	" 28	" 5	" 12
14	" 22	" 28	" 5	" 16
15	" 22	" 28	" 5	" 12
17	" 22	" 28	" 5	" 16
18	" 22	" 28	" 9	" 17
19	" 22	" 28	" 5	" 15
20	" 22	" 28	" 5	" 14
21	" 22	" 28	" 12	" 15
22	" 22	" 28	" 5	" 12
24	" 22	" 28	" 5	" 12
26	" 22	" 28	" 5	" 12
27	" 22	" 28	" 5	" 15

TABLE 10.—*Head width of instars of Pandemis limitata Rob., previous to hibernating, 1929.*

Record No.	Head width 1st instar	Head width 2nd instar	Head width 3rd instar	Width of cast head in hibernaculum	Head width of larva in hibernaculum
1	.243	.356	.518	broken	.615
2	.247	.356	.502	"	.518
3	.241	.340	.486	"	.550
4	.234	.335	.469	"	.502
6	.238	.340	.469	"	.518
7	.238	.342	.494	failed to hibernate	
9	.243	.356	.494	broken	.518
10	.251	.370	.538	.518	.551
11	.234	.330	.421	failed to hibernate	
12	.255	.341	.486	broken	.518
13	.243	.351	.502	"	.567
14	.251	.380	.486	.460	.502
15	.249	.380	.502	broken	.534
17	.251	.388	.534	"	.567
18	.251	.384	.534	"	.567
19	.247	.360	.486	.469	.502
20	.243	.352	.502	.486	.518
21	.234	.331	.437	.429	.494
22	.241	.356	.550	broken	.599
24	.243	.372	.502	"	.567
26	.241	.356	.502	"	.536
27	.235	.352	.502	"	.519

occur. In any event the bud injury is not a serious factor in Annapolis valley orchards with the present degree of infestation. The amount of leaf area consumed at any time is small, and injury in this respect is not likely to be serious.

On trees well set with fruit it was common to find newly formed apples with deep holes gnawed into the surface. A large percentage of such fruit dropped prematurely. Of those that remained it was observed that the injured surface healed and the resulting scars at picking time were similar to those caused by green fruit worms.

The newly hatched or summer brood larvae on coming into contact with the fruit, produce a definite type of side injury. This consists of one or several small circular holes through the skin. After the attached leaf under which they feed has been deserted and removed by wind or rain, there usually develops a circular reddish or purple area around the point of injury. This develops only after the injured fruit surface is exposed to the sun, such coloring being quite unique. This side injury to the fruit as it begins to mature is the most serious.

Economic Importance. This species has not been observed in Nova Scotia in epidemic form, nevertheless in the Berwick and Lakeville districts considerable injury to the fruit has been recorded. In one orchard there was 7.67 per cent of marked fruit on one variety. Other orchards indicated from 1 to 5 per cent of damaged fruit due to this insect. In all of these orchards severe outbreaks of *Spilonota ocellana* D. & S. had been present for some time. It is apparently due in a great measure to the latter insect providing an environment suitable for *Pandemis limitata* Rob. that the present numbers in these orchards are now found. Its habits are such, as already explained, that a companion species seems necessary in order for it to increase in any given area, and as *Spilonota ocellana* D. & S. is the most important in this respect, *Pandemis limitata* Rob. will probably fluctuate up and down according to the degree of infestation of *Spilonota ocellana* D. & S.

Parasites. During the time the three-lined leaf roller has been under study parasites have not been sufficiently numerous to be of any material assistance in reducing the larval population. In 1929, a few hymenopterous parasites were recovered, including at least two species of ichneuman flies.

Description of the Life Stages of *Pandemis limitata* Rob.

EGG

The individual egg averages .923 mm. long by .705 mm. wide, scale like, flattened, oval in outline, chorion delicate, finely and irregularly reticulated. In colour, they are yellowish-green when laid, turning more distinctly yellowish or very pale orange as the embyro develops, at the same time becoming granular. Two or three days before hatching the dark eye spots and rusty mandibles of the larva are faintly distinguishable. At the same time the yellow colour largely disappears, the egg becoming darker and duller. A few hours previous to emerging the tiny larvae can be observed curled up like the letter U beneath the delicate egg covering.

Larva

First Instar. Width of head .234 to .251 mm. Total length of body 1.86 mm. Head pale amber, shiny, ocellar area blackish, mandibles rusty at teeth, paler at base; antennae whitish, semi-translucent; setae short, fine, and pale. On lateral margins of epicranium is a narrow dusky border extending to pro-thorax. Pro-thoracic shield straight in front, rounded behind, slightly wider than head, pale yellowish-green, shining. Body pale yellow; pro-legs and anal plate concolorous with body; tubercles of the body colour, raised rugose; setae not long, pale and fine with a brownish circle at base; spiracles small, circular, anal fork distinguishable.

Second Instar. Width of head .330 to .388 mm. Total length of body 2.88 to 3.50 mm. The caudal third of the pro-thoracic shield is olive-green and darker than the cephalic portion. The anal plate is nile green. The general appearance of the larva in other respects in this instar is much the same as the preceding one.

Third Instar. Width of head .421 to .550 mm. Total length of body 4 to 5 mm. The narrow border on lateral margins of head is blackish, pro-shield nile-green; in other respects as the previous instars.

Fourth Instar (from hibernaculum). Width of head .494 to .615 mm. Total length of body 1.81 to 2.42 mm. Head black, occasionally dark brown, shining; clypeus whitish; mandibles brown; setae fine and pale. Prothoracic shield black or dark olive-green. Body yellow with a tinge of green, contracted; tubercles dusky, prominent; setae short, fine and pale; spiracles circular, dark rimmed; prolegs same colour as venter with a dusky crescent shaped area at base on outside; feet nile-green, pale at joints; anal plate pale nile-green; anal fork present but not prominent.

Fifth Instar. Width of head .699 to .885 mm. Total length of body 6 to 8 mm. Head light amber or pale green; ocellar area black with lenses transparent; clypeus whitish; mandibles brown; setae not long, fine and pale. Low on lateral margins of epicranium is a narrow blackish border extending to pro-thorax. Pro-shield olive-green, darker on caudal third. Body a dull yellowish-green; tubercles raised, rather prominent, of the body colour; setae pale, medium length; spiracles small, circular, dark rimmed; pro-legs concolorous with venter, feet blackish; anal plate concolorous with body, inconspicuous; anal fork not prominent.

Sixth Instar. Width of head 1.07 to 1.583 mm. Total length of body 11. to 13.5 mm. Except that the body is somewhat more green with the venter slightly paler than dorsum, the general appearance of the larva is much the same as the previous instar.

Seventh Instar. Width of head 1.379 to 1.811 mm. Total length of body when first moulted 16 to 18 mm., when full grown 19 to 23 mm. Head light green or pale amber with darker amber mottlings as figured in head capsule, mandibles brownish at teeth, paler at base, clypeus pale; a narrow black area low on caudo lateral margins extending to pro-thorax, setae pale, medium length, ocellar area blackish. Head capsule wider than long, greatest width across head where adfrontal and longitudinal ridges meet, incision of dorsal hind margin between one-seventh and one-eighth width of head; distance between dorsal extremeties of hind margin less than one-half width of head; adfrontal sutures extending to incision of dorsal

hind margin. Longitudinal ridges greater than one-third length of frons, frons high, longer than broad, reaching beyond middle of head. Ocelli six, III, IV and V close together in a straight line with heavily chitinized borders, II and III not heavily chitinized, II equal distance from I and III, VI not clearly defined. In cleared and prepared mounts all the primary setae and punctures distinguishable, except SO_2, which could not be observed. Frontal punctures close together, distance from frontal setae F^1 to first adfrontal setae Adf^1 less than from Adf^1 to Adf^2. Anterior setae (A^1, A^2, A^3) viewed from side form an obtuse angle, from above all are in a straight line with L^1; ocellar setae (O^1, O^2, O^3) well separated, O^2 approximately equal distance from O^1 and O^3; O^1 equal distance from ocelli I and II, ventrad of ocelli II and III and in line with I and IV; subocellar setae triangularly grouped distance from SO^2 to SO^1 greater than SO^2 to SO^3. Pro-thoracic shield same colour as head, usually darker on caudal margin, frequently there is a small blackish area on the caudo lateral margins. Body colour yellowish-green with a darker green stripe on mediodorsal line; venter paler than dorsum; tubercles raised, rugose, rather prominent, those each side of dorsal line slightly lighter in colour than surrounding body surface; spiracles small, slightly produced, brown rimmed, those on thorax and eighth abdominal segment larger than spiracles one to seven on abdomen; pro-legs colour of venter crochets uniserial, of three lengths but not uniformly triordinal; feet also of body colour, tarsus brown; anal plate rather large, concolorous with dorsum, not conspicuous; anal fork 6 to 8 pointed.

Pupa

Total length 10.25 to 12.34 mm., average width 2.99 mm. When first formed head and thorax including wings light green; eye spots either same colour as head or dark brown; abdomen yellowish-brown. The wings gradually change in colour to yellowish-brown and frequently dark brown, the abdomen also becomes somewhat more brown with the dorsal surface darker than the ventral; cremaster dark brown. Fronto-clypeal suture not distinct, two pairs clypeal setae of about equal length, suture between labrum and clypeus faint. Pro-thoracic legs extending one-half way to tip of wings, their femora exposed, reaching to end of maxillae; mesothoracic legs not reaching to tip of wings; metathoracic legs and tips of wings reaching slightly beyond cephalic edge of fourth abdominal segment; antennae reaching slightly beyond mesothoracic legs. Pro-leg scars faintly distinguishable on abdominal segments, 4, 5 and 6; spiracles darker than body, produced, pointing caudad, those on first abdominal segment covered. Two transverse rows of spines on dorsum of abdominal segments 2 to 8, extending on sides to spiracles; spines small on segments 2 and 3, fewer in number and small on caudal row of segment 8, on segment 9 cephalic row wanting, a few small regularly placed spines on caudal row. Cremaster longer than wide, prominent, with shallow longitudinal grooves, four hooks at extremity curved ventrad at tips, two similar hooks on each caudolateral margin; genital openings slit-like in both sexes, the male with faint elevations on either side; anal opening slit-like situated on a moderate anal rise. There is independent movement between the segment 7 and 8 of the male, in the female there is no movement between these segments.

ADULT

The adult of this species was described by Robinson in "Transactions American Entomological Society, 1868-9." The Nova Scotia forms are pale reddish-brown with three fine pale oblique lines across the forewings. The base and space between the outer two lines considerably darker. There is a triangular area same colour as base also, with a pale outline on the outer half of the costal margin. The hind wings are pale with cinnamon markings on the outer margin and smoky at anal angle. The labial palpi project out conspicuously in front and usually carried in that position. The males have the same markings as the females, but as a rule are darker with greater colour contrast. When spread the adults vary from 18 to 26 mm. across the wings, the females usually being the larger.

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Plate 1. *Pandemis limitata* Rob.; larva

1. Labrum.
2. Epipharynx.
3. Mandible.
4. Lateral view of head capsule.
5. Dorsal view of head capsule.

EXPLANATION OF SYMBOLS APPLIED TO HEAD

A1, A2, A3, Aa—Setae and puncture of anterior group of epicranium. Adf1, Adf2, Adfa—Adfrontal setae and puncture of epicranium. ADFR—Adfrontal ridge of larval head. ADFS—Adfrontal suture of larval head. E1, E2—Epistomal setae. F1, Fa—Frontal setae and puncture of epicranium. FR—Frons of epicranium. G1, Ga—Genal setae and puncture of epicranium. L1, La—Seta and puncture of lateral group of epicranium. LR—Longitudinal ridge of epicranium. O1, O2, O3—Setae of ocellar group of epicranium. p1, p2, pa, pb—Setae and punctures of posterior group of epicranium. SO1, SO2, SO3 — Setae of subocellar group of epicranium. X—Ultra posterior setae and puncture of epicranium. M1, M2, M3, Ma—Medium group of setae and puncture of labrum. La1, La2, La3—Lateral group of setae of labrum. ER—Epipharyngeal rods. ES—Epipharyngeal shield. ET—Epipharyngeal setae. Ar—Posterior articulation of mandible.

Plate 2. *Pandemis limitata* Rob.

1. Pupa, male, ventral view.
2. Pupa, male, dorsal view.
3. Pupa, male, caudal extremity, showing anal and genital openings.
4. Pupa, female, caudal extremity, showing anal and genital openings.
5. Male genitalia.
6. Wing venation, female.

EXPLANATION OF SYMBOLS APPLIED TO PUPA

a—antenna. a, 1 to 10—abdominal segments. ao—anal opening. cl—clypeus. cr—cremaster. cx2—coxa of the mesothoracic leg. f—front. f1—femur of prothoracic leg. ge—glazed eye-piece. go—genital opening. lb—labrum. l1—prothoracic leg. l2—mesothoracic leg; l3—metathoracic leg. lp—labial palpi. md—mandibles. mp—maxillary palpus. ms—mesothorax. mt—metathorax. mx—maxilla. p—prothorax. se—sculptured eye-piece. v—vertex. w1—mesothoracic wing. w2—metathoracic wing.

EXPLANATION OF SYMBOLS APPLIED TO GENITALIA

ae—aedoeagus. Jx—juxta. Cn—cornuti. Hp—harpe. Gn—gnathos. U—uncus. Vm—vinculum. Tg—tegumen. Ts—transtilla.

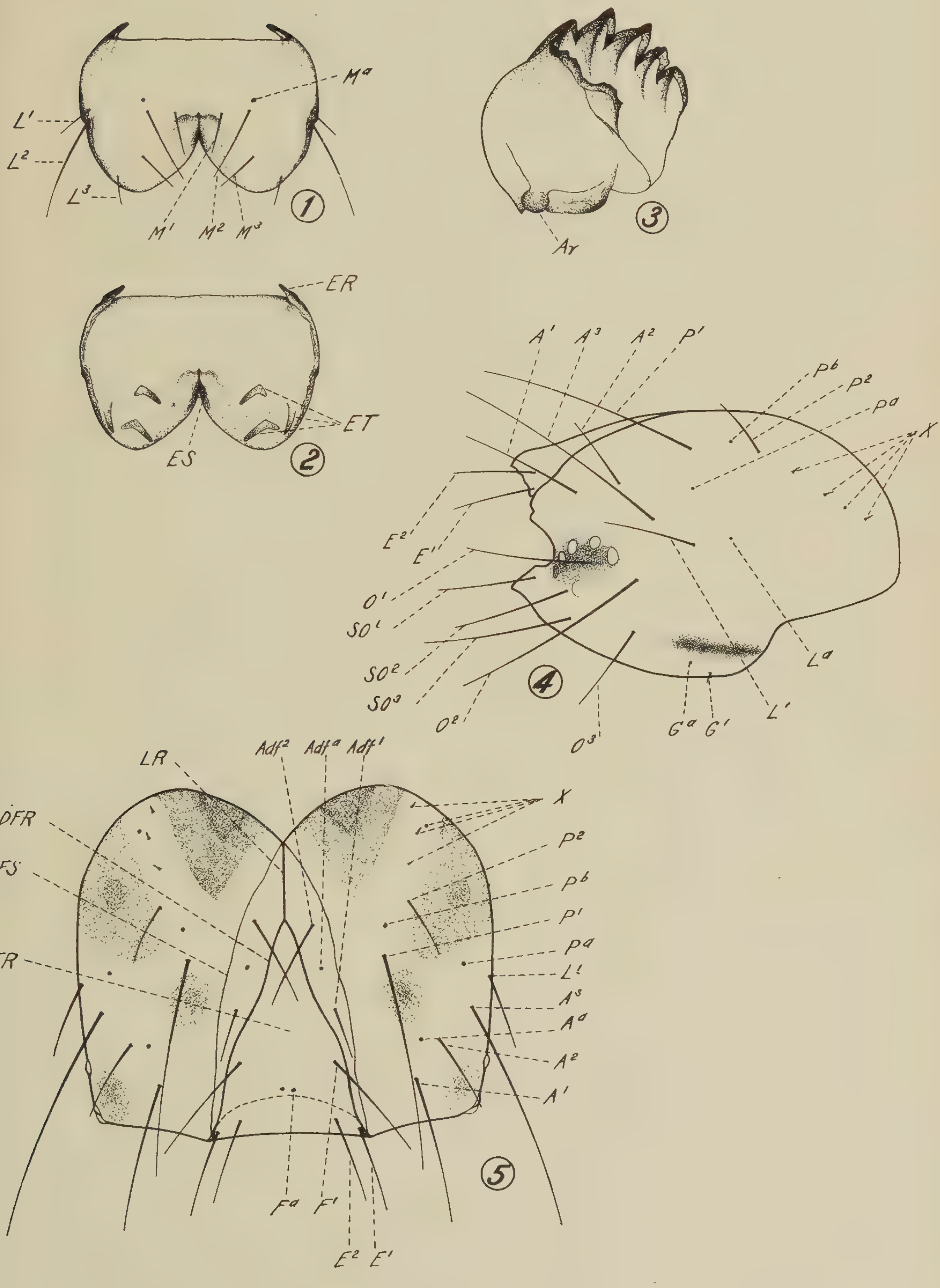

Plate 1. See page 518.

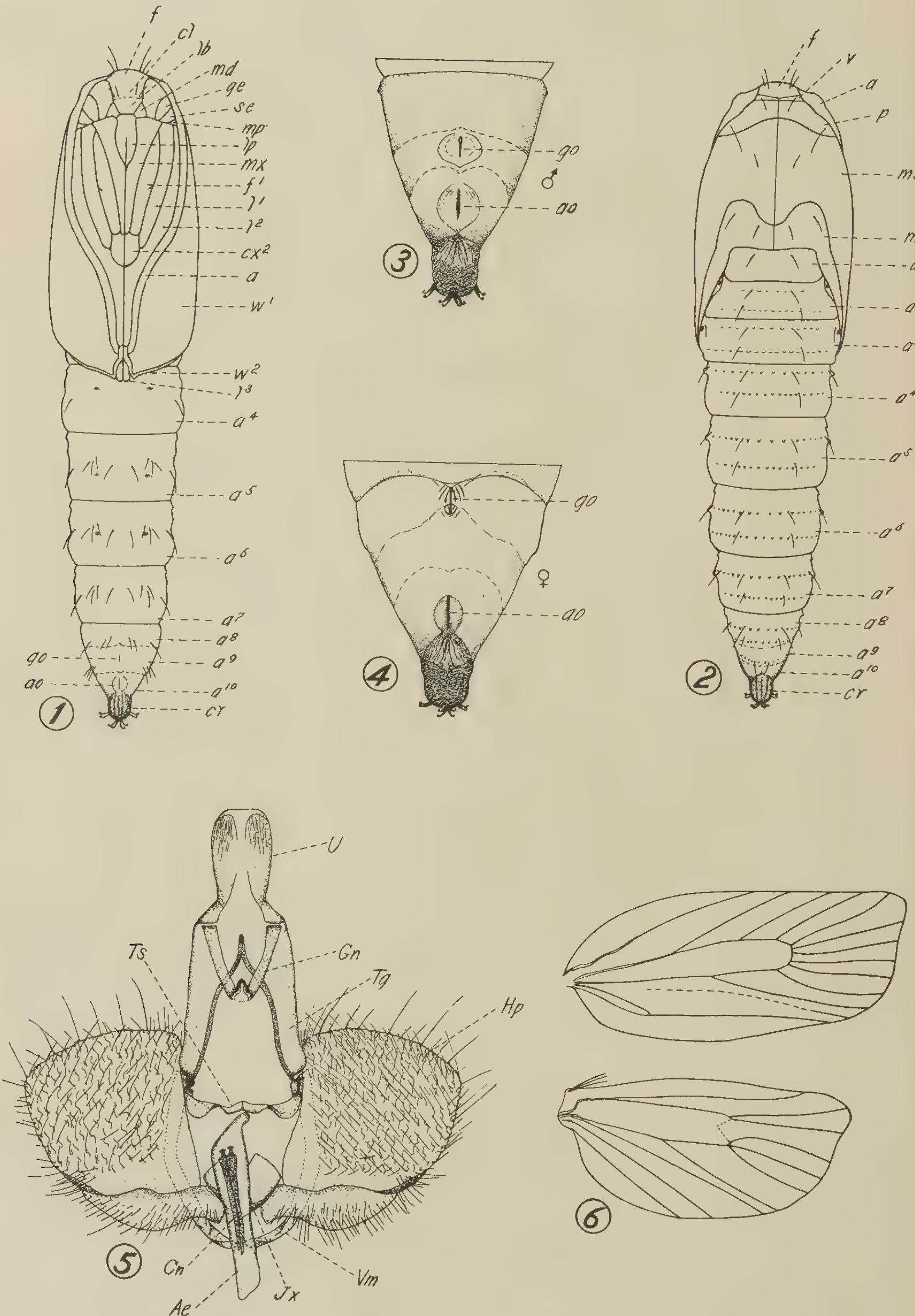

Plate 2. See page 518.

Plate 3. *Pandemis limitata* Rob.

1. Apples injured by the larvae previous to hibernating.
2. Newly formed apples showing the deep scars produced by the over-wintering larvae.
3. Egg mass on leaf.
4. Adult moths, male and female.

VENTE COOPERATIVE DES ANIMAUX VIVANTS DANS LA PROVINCE DE QUEBEC

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Le bétail de boucherie est devenu un article dont le commerce, dans la Province de Québec, a pris des proportions particulièrement grandes au cours des dernières années. L'élevage des animaux pour fins de boucherie est encore considéré chez nous, et à bon droit sans doute, comme une de nos industries agricoles d'ordre secondaire. Mais fournir à plus de dix millions de bouches les viandes dont elles ont besoin pour leur alimentation constitue une industrie qui ne peut être une source de revenus à négliger, encore moins à ignorer, surtout dans un temps où chaque sou compte autant qu'aujourd'hui pour équilibrer un budget de ferme.

Pour faire voir quelles proportions prend le commerce du bétail de boucherie dans notre pays, j'ai tiré des statistiques fédérales les quelques chiffres suivants qui donnent les quantités d'animaux vivants vendus sur les marchés publics du Canada pendant l'année 1931. Ces chiffres ne tiennent nul compte des expéditions faites directement aux maisons de salaison, et il nous est permis d'estimer que celles-ci reçoivent à peu près autant d'animaux qu'il y en a d'offert sur les marchés publics. Il ne faudrait pas oublier non plus que ces chiffres laissent de côté tous les animaux abattus sur nos fermes et vendus sur les marchés de certaines villes qui n'imposent pas le règlement que toutes les viandes consommées dans leurs limites soient abattues dans des abattoirs publics.

Il s'est vendu sur les cours à bestiaux publiques au cours de la dernière année, ainsi qu'en 1930:—

Bêtes à cornes	646,489	606,489
Veaux	307,082	311,756
Porcs	1,084,582	904,439
Moutons	527,102	483,645

Nos exportations, pour 1931, se chiffrent à 17,500,000 de livres de porc abattu, 3,900 porcs vivants, un quart de million de livres de mouton abattu et 40,217 têtes de bétail, dont 27,149 exportées en Angleterre.

Si nous groupons toutes nos importations nous arrivons à un peu plus que 12,000,000 de livres pour 1931, alors qu'elles avaient été d'au delà de 33,000,000 de livres au cours de l'année précédente.

Bien que Québec doive être considérée comme une de nos provinces canadiennes où il se produise le moins d'animaux de boucherie, nous arrivons aux chiffres suivants pour les deux dernières années:

	1931	1930
Bétail	26,888	34,185
Veaux	85,917	97,648
Porcs	111,893	82,827
Moutons	146,039	133,779

Ces chiffres feront voir que le commerce du bétail de boucherie n'est pas sans importance et qu'il représente pour notre producteur une source non négligeable de revenus.

Il suffit d'avoir parcouru nos campagnes de Québec pour que l'on se rende bien compte, par le grand nombre et la prospérité des commerçants animaux vivants, que la vente du bétail de boucherie, même chez nous, constitue une petite mine dont les cultivateurs pourraient tirer un profit beaucoup plus considérable qu'ils ne l'ont fait peut-être par le passé.

Mais je n'ai nullement l'intention de vous faire valoir les avantages, qui ne manquent pas d'intérêt, de la production des animaux vivants pour fins de boucherie. Je voudrais plutôt vous dire un mot de ce qui a été fait par la coopération pour empêcher que les producteurs ne soient trop exploités dans la vente de leurs animaux vivants.

Le bétail de boucherie est un article d'une caractère marchand manquant d'uniformité et cette particularité, que l'on ne rencontre que dans un beaucoup moindre degré dans le blé, le lait, le beurre, le fromage, les oeufs, par exemple, constitue un obstacle à la standardisation, ainsi qu'au commerce d'après échantillons, en sorte que les animaux doivent, et devront encore longtemps, se vendre à la pièce. Il n'y a d'exception, et encore est- elle assez relative, que pour les porcs qui se prêtent à une classification assez satisfaisante. Un autre obstacle qui impose des conditions particulièrement désavantageuses au commerce du bétail de boucherie est qu'il doit être vendu à un temps donné sans qu'il puisse souffrir de voir sa vente retardé longtemps. Quand vient le temps de vendre, il faut disposer des animaux quelles que soient les conditions existant sur nos marchés. La viande ne se prête que difficilement à la constitution de stocks comme le blé, le beurre. Il est vrai que la congélation et la salaison permettent de rémédier partiellement à cet état de choses, mais pas suffisamment pour que le producteur puisse en bénéficier beaucoup.

Ces causes, ausquelles il faut ajouter les influences du commerce, celles de la foule des intermédiaires, qui, entre parenthèses, sont peut-être plus nombreux ici qu'ils ne le sont pour tout autre produit agricole, mettent le cultivateur dans le cas de n'avoir que bien peu à dire dans l'établissement des prix. Et le cultivateur, dans la province de Québec, a eu longtemps à subir, de ce fait, un système de vente qui lui rapportait une proportion dérisoire du prix que payait le consommateur pour les animaux vivants.

On conçoit que si le commerce honnête a intérêt à exercer une pression sur les prix aux dépens du producteur, tel doit bien être davantage le cas du commerçant qui ne cran pas de recourir à toutes sortes de pratiques douteuses, voire même frauduleuses. Chacun de vous sait par expérience à quels expédients ont parfois recours ceux qui rendent au cultivateur le service, toujours très grand, de lui acheter ses animaux. Le marché est toujours, à les entendre, à la baisse; les animaux n'ont pas la qualité voulue; c'est pour leur aider qu'on se dérange autant qu'on le fait; nul dévouement autant que le leur n'est aussi désintéressé; aucun ne s'inspire d'autant de charité, d'affection, et peu s'en manque parfois pour qu'on n'affirme pas avec le plus grand sérieux, et avec certaines chances d'être cru, que

l'acheteur n'a en vue que le plus grand intérêt du producteur. Il est inutile d'insister là-dessus, car vous n'avez certainement pas manqué de vous rendre compte que le commerce des animaux vivants est un de ceux qui enrichit le plus rapidement son homme.

Les cultivateurs et leurs organisations ne pouvaient assister impassibles aux agissements de ceux qui les exploitaient; aussi nos coopératives s'intéressèrent-elles très activement à cette question. Dès 1917, nous voyons la Coopérative Centrale de Québec ouvrir un départment des animaux vivants qui rendit de si grands services qu'il a subsisté jusqu'à ce jour après avoir passé par la Coopérative Fédérée de Québec pour se muer ensuite en la Coopérative Canadienne du Bétail Limitée. L'ouverture de ce département de l'ancienne Coopérative Centrale, suivi peu de temps après par un département identique au Comptoir Coopératif de Montréal, marqua le début, dans la province de Québec, d'une lutte sans merci de la part du commerce contre le système de la vente en coopération, lutte dont l'intensité ne s'est pas relâchée depuis et dont nous avons, aujourd'hui encore, à souffrir considérablement, mais il nous fait plaisir de dire que nous nous immunisons graduellement contre les atteintes de la maladie que fait toujours le commerce lorsque le cultivateur se décide à prendre en main les intérêts dont la surveillance avait beaucoup trop longtemps été laissée au commerce.

Les débuts de la vente coopérative des animaux vivants furent lents et parfois même pénibles. La classification, si elle donnait satisfaction aux producteurs de bons animaux, se faisait à elle-même, et à la coopération tout naturellement, des ennemis presque irréductibles de pratiquement tous ceux qui expédiaient des animaux dont la qualité laissait à désirer. Mais malgré cela, et malgré les très nombreuses difficultés qu'elle eut à affronter, la vente coopérative des animaux vivants s'implantait chez nous pour rester, et, en 1929, lorsque la Coopérative Fédérée de Québec se décida à adhérer au mouvement de la Coopérative Canadienne du Bétail Limitée, elle faisait pour presque un million de dollars d'affaires par année, dans son département des animaux vivants.

Les causes qui ont amené l'établissement de la Coopérative Canadienne du Bétail Limitée peuvent se réduire à deux chefs principaux:—1o—réduire les frais d'administration en éliminant des bureaux de ventes coopératifs trop nombreux sur nos différents marchés canadiens: 2o—éliminer la concurrence que se faisaient entre elles les coopératives provinciales, particulièrement sur nos trois grands marchés canadiens: Montréal, Toronto et Winnipeg.

Après que Québec eut organisé son système de vente coopérative les autres provinces ne tardèrent pas à nous suivre dans cette nouvelle voie et en 1929 les différentes provinces se faisaient par l'entremise de leurs copératives une lutte des plus nuisibles dans le commerce des animaux vivants. Montréal, grâce à sa population d'au delà d'un million, était devenu un champ de bataille sur lequel les coopératives de chaque province luttaient les unes contre les autres pour y écouler les produits qu'elles avaient en trop pour les besoins de leurs marchés locaux. Montréal est reconnue comme étant le meilleur marché que nous ayons au Canada, celui où les prix sont toujours les plus élevés. Aussi n'est-il pas surprenant que nous

trouvions ici, en outre du Département des Animaux Vivants de la Coopérative Fédérée de Québec, un bureau de vente de la United Farmers Co-operative Co. Limited de l'Ontario, ainsi qu'une foule de maisons à commission qui représentaient les Provinces Maritimes, le Manitoba, la Saskatchewan et l'Alberta. Il faut aussi ajouter que l'Union des Cultivateurs avait également un département des animaux vivants.

On conçoit quelles conditions devaient être faites aux producteurs par une lutte où tant d'éléments de concurrence n'étaient controlés par aucune entente entre ces différentes organisations qui toutes avaient à coeur la défense des intérêts des producteurs.

La situation devint telle que les différentes coopératives, la Coopérative Fédérée tout particulièrement, réalisèrent que cette lutte devait cesser si les intérêts du cultivateur devaient être protégés efficacement. Un rapprochement fut tenté et c'est de l'entente qui en résulta que naquit la Coopérative Canadienne du Bétail Limitée.

La Coopérative Canadienne du Bétail Limitée est constituée, du moins elle l'était à ses débuts, de six grandes coopératives provinciales s'intéressant à la vente coopérative des animaux vivants. Depuis le mois de septembre dernier la Colombie Anglaise s'est ralliée au mouvement. Les six organisations qui ont contribué à son établissement sont:—

Maritime Live Stock Board Inc., pour les Provinces Maritimes: Ile du Prince Edouard, Nouvelle Ecosse et Nouveau Brunswick.

La Coopérative Fédérée de Québec, pour la province de Québec.

The United Farmers Co-operative Company Limited pour l'Ontario.

The Manitoba Co-operative Livestock Producers Limited pour le Manitoba.

The Saskatchewan Co-operative Livestock Producers Limited pour la Saskatchewan.

The Alberta Co-operative Livestock Producers Limited pour l'Alberta.

Et nous avons maintenant la Coopérative Canadienne du Bétail Limitée, bureau de Vancouver, pour la Colombie Anglaise.

Plusieurs de ces organisations ont à présent pris le nom de Coopérative Canadienne du Bétail, notamment les Provinces Maritimes, Québec, Manitoba, Alberta et la Colombie Anglaise. Les autres provinces prennent les mesures voulues pour effectuer ce changement de nom.

Cette organisation est maintenant représentée sur tous les marchés publics du Canada où s'effectue la vente d'animaux vivants; nous avons même certains bureaux à des endroits où il n'y a pas encore de marchés publics. Chaque bureau est indépendant de son voisin et est dirigé par un Gérant qui peut compter sur l'assistance d'un comité spécial, dit Comité de l'Est pour les bureaux des Provinces Maritimes, de Québec et de l'Ontario, et Comité de l'Ouest pour les bureaux des provinces Manitoba, Saskatchewan, Alberta et Colombie Anglaise.

Le Bureau-chef de l'organisation est à Montréal. M. J. K. King en est le Secrétaire. Ce bureau agit comme agent de liaison entre les différentes branches de la société, mais n'a pas à intervenir directement dans les affaires de chaque bureau de vente. L'Exécutif de la Coopérative

Canadienne du Bétail, élu chaque année à l'assemblée générale, est l'autorité suprême dans l'administration générale de l'organisation, mais en autant qu'il se conforme aux directives tracées par les assemblées générales.

Pour faire ressortir la portée et l'importance de ce mouvement relativement jeune encore, qu'il me suffise de mentionner que les divers organismes provinciaux de la Coopérative Canadienne du Bétail Limitée ont reçu en 1931 un peu plus que 40% de toutes les expéditions qui ont été faites en vue de la vente publique sur tous les marchés publics du Canada.

Voici quelles ont été ces quantités, réparties selon les espèces, ainsi que le nombre de chars et de camions:—

Bétail	175,617
Veaux	46,105
Porcs	606,501
Moutons	221,235
Chars	14,843
Camions	10,355

Le bureau de vente de Montréal, à la fondation duquel la Coopérative Fédérée de Québec a le plus contribué, a été le premier à opérer sous le nom de la Coopérative Canadienne du Bétail Limitée; il fut ouvert le 1er septembre 1929. Ce bureau est en somme le résultat de la fusion du Département des Animaux Vivants de la Fédérée, ainsi que de celui que la United Farmers Co-operative Co. Limited de l'Ontario tenait ouvert sur le marché de Montréal jusqu'à 1929. Il nous fait plaisir de rappeler que depuis le 1er décembre, 1930, l'Union Catholique des Cultivateurs fait vendre tous ses animaux vivants par l'entremise de la Coopérative Canadienne du Bétail, en sorte que cette organisation est réellement la seule coopérative qui dans notre province s'occupe de la vente coopérative des animaux vivants.

Permettez que je vous cite encore quelques chiffres; ils font ressortir mieux que je ne saurais le faire autrement le rôle que joue cette organisation dans le commerce des animaux vivants sur le marché de Montréal qui est en somme le seul marché de quelque importance que nous ayons pour absorber le surplus de nos campagnes.

Nous avons reçu en :—

	1931		1930	Augmentation
Chars	2,495		1,696	47.11%
Camions	585		309	88.67%
Bétail	15,341	(3435)	6,892	122.61%
Veaux	15,469		12,078	28.24%
Porcs	78,110		56,975	37.10%
Moutons	63,406		64,771	2.10%

Ces chiffres font voir une augmentaion très substantielle dans les quantités reçues. Et bien que les prix aient subi une dépréciation très prononcée au cours de la dernière année, notre chiffre d'affaires dépasse sensiblement les deux millions et quart accusant une augmentation de 10.96%.

Une comparison d'un intérêt tout particulier est celle des quantités reçues par la Coopérative Canadienne du Bétail Limitée avec celles mises en vente sur les Cours à Bestiaux de la Pointe St-Charles. Le tableau suivant fait voir la relation qui existe entre ces chiffres.

	C.C.B.	C. à B.	notre %
Bétail	15,341	54,376	28.21%
Veaux	15,469	103,128	15.00%
Porcs	78,110	172,792	45.20%
Moutons	63,406	136,380	46.49%
Total	172,326	466,326	36.92%

Je ne doute pas que vous soyez curieux de savoir d'où nous viennent les animaux que nous recevons. Voici comment les différentes provinces se répartissent nos expéditions. Québec a naturellement la part du lion avec 52.2%.

Provinces Maritimes	2.7%
Québec	52.2%
Ontario	19.2%
Manitoba	12.9%
Saskatchewan	6.4%
Alberta	6.6%

Une objection qui nous est parfois faite est celle-ci: "Mais vous encouragez l'expédition d'animaux venant des autres provinces et vous êtes ainsi cause que nos produits du Québec aient à souffrir la concurrence des produits des autres provinces."

Ceci peut paraitre, à première vue, une objection de valeur. Il n'en est rien cependant, tout au contraire, et il suffit de l'étudier d'un peu près pour s'en convaincre. Voici pourquoi. La production de notre province ne suffit pas à alimenter nos marchés domestiques, et il s'en manque de beaucoup. Il faut donc aller trouver là où il s'en produit les viandes dont nous avons besoin. Le commerce, à moins que nous ne lui fournissions ce qu'il lui faut, verra à se procurer lui-même et directement ce dont il a besoin. Par les constatations de ce qui se passe sur nos marchés, il est facile de se rendre compte de la chose. Ainsi en recevant des expéditions des autres provinces, nous ne nuisons nullement à notre marché, puisque ces mêmes expéditions seraient amenées ici même si nous ne nous en occupions pas et beaucoup plus irrégulièrement qu'à présent, provoquant ainsi des encombrements dont on ne connait que trop les conséquences désastreuses. En recevant nous-mêmes ces expéditions, il nous est possible d'en régulariser la venue et de diriger ailleurs ce qui serait de trop pour les besoins immédiats de nos débouchés locaux. Nous avons à Winnipeg un département spécial qui a justement comme fonction de distribuer aussi équitablement et régulièrement que possible les expéditions qui sont dirigées de l'Ouest vers les grands centres de consommation de l'Est, Toronto et Montréal surtout.

Il y a un autre côté à cette question des expéditions venant des autres provinces, c'est qu'elles nous permettent de vivre. Les commissions que charge la coopérative Canadienne du Bétail sont si faibles que les seules expéditions que nous recevons de la province de Québec seraient

bien insuffisantes à subvenir à tous nos frais d'opération. Les commissions que nous recevons sur les expéditions extra-provinciales nous permettent de suppléer à ce qui nous manquerait s'il nous fallait compter uniquement sur les expéditions de Québec.

Si la Coopérative Canadienne du Bétail Limitée a remporté des succès réels depuis son organisation, elle ne le doit pas uniquement à elle-même, à son système d'opération ou à ses officiers. Il y a d'autres éléments qui lui furent d'une grande assistance. Parmi ceux-ci, je désire mentionner la campagne en faveur de la vente coopérative des animaux vivants qui fut lancée par nos deux ministères de l'agriculture, lesquels mirent dans nos campagnes chacun trois hommes ayant comme activité principale de promouvoir la vente en coopération des animaux vivants, tout en faisant de la propagande en faveur de l'amélioration de nos méthodes d'élevage, de sélection et d'alimentation. Ces six hommes sont fréquemment appelés, à tort, les propagandistes de la Coopérative Canadienne du Bétail. Ce sont des employés du Gouvernement Fédéral ou Provincial, selon le cas. Mais comme tous devaient travailler dans un seul et même sens, il fut entendu que les deux ministères délègueraient la direction de ces six hommes a un comité de trois composé comme suit: M. MacMillan, représentant du Ministère Fédéral, M. Adrien Morin, représentant du Provincial et M. Desmarais, représentant de la Coopérative Fédérée de Québec. Il n'y a pas de doute que ces hommes ont grandement aidé au mouvement coopératif tel que compris par les promoteurs de la Coopérative Canadienne du Bétail. Mais elle le doit aussi au concours très sympathique que lui ont accordé toutes nos organisations agricoles, toutes les personnes quelque peu intéressées aux questions agricoles dans notre pays.

Un fait sur lequel on me permettra d'attirer votre attention est que la Coopérative Canadienne du Bétail, dans la Provincede Québec, est la seule organisation à s'occuper maintenant de la vente coopérative des animaux vivants. Et il me fait plaisir de mentionner ici que c'est dans le seul domaine de la vente coopérative des animaux vivants que la Coopérative Fédérée de Québec et l'Union Catholiques des Cultivateurs sont absolument d'accord, puisque depuis le 1er décembre 1930, l'Unon Catholique des Cultivateurs fait vendre les animaux de tous ses membres par l'entremise de notre Organisation. C'est là, il me semble, un témoignage de réelle valeur à l'égard de notre organisation.

Une note que je lisais récemment dans un rapport publié par le Ministère de l'Agriculture d'Ottawa a attiré mon attention et je me permets de vous la répéter: "Il n'est pas rare pendant les périodes de dépression économique de constater que certains coopérateurs tendent à attribuer la chute des prix à quelque défaillance de leurs organisations. Cette tendance à associer l'idée de coopération avec celle d'un "contrôle", d'une maitrise des prix, a peut-être été encouragée dans une certaine mesure par la littérature coopérative, mais, à ce propos, la chute des prix n'aurait-elle pas été encore plus grave si les grandes coopératives n'avaient pas exercé une influence régulatrice sur les marchés?"

Nous sommes heureux de dire qu'à notre connaissance, nous ne nous sommes jamais aperçu que les coopérateurs de quelque province que ce

soit au Canada aient jamais eu la pensée d'appliquer une critique de ce genre à la Coopérative Canadienne du Bétail Limitée. C'est tout le contraire que nous constatons. En effet même des gens qui sembleraient ne pas devoir entretenir les sentiments les plus sympathiques à notre endroit faisaient une remarque dont je tire les quelques conclusions suivantes à votre intention, et je terminerai par là.

Tout dernièrement des représentants autorisés de maisons de salaison reconnaissaient que si ce n'eût été des exportations de bouvillons faites par la Coopérative Canadienne du Bétail en Angleterre au cours de l'été dernier, les prix des bêtes à cornes auraient été d'au moins un demi sou, peut-être même un sou plus bas qu'ils ne l'ont été. Si nous nous arrêtons à calculer ce que peut représenter ce demi sou, nous nous rendons facilement à un montant dépassant de beaucoup les $100,000.00 que nous aurions fait économiser et gagner aux cultivateurs canadiens par cette seule intervention de notre part dans l'exportation des animaux vivants.

Et maintenant si des personnes, qui ne bénéficient certainement pas de notre existence, peuvent donner un témoignage aussi flatteur que celui-là à notre organisation, n'est-ce pas là une preuve absolument probante de la valeur des services que peut rendre la Coopérative Canadienne du Bétail? Il serait facile de vous citer d'autres exemples aussi probants que celui de l'exportation des bêtes à cornes; le cas des porcs, celui des moutons, se prêteraient à des illustrations qui ne manqueraient pas d'intérêt et qui mettraient en lumière la nature des services rendus par cette organisation. Mais je ne le ferai pas de crainte de m'aliéner, par mes longueurs, votre sympathie, ce que je ne voudrais pas faire pour tout au monde, car, à la Coopérative Canadienne du Bétail, nous l'apprécions trop pour ne pas savoir que nous en avons grand besoin et que sans elle nous aurions grande chance de voir nos moyens d'action très appréciablement paralysés.

RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

La Ration Nutritive Defectueuse Comme Facteur de Maladie. J. B. Orr, Directeur du Bureau Impérial de Nutrition Animale, Rowett Research Institute, Aberdeen, Scotland.

L'auteur souligne l'importance d'une ration nutritive bien balancée tant au point de vue des vitamines et des matières minérales qu'à celui des principaux groupes de manières nutritives.

Tout en faisant remarquer qu'un nombre considérable d'animaux meurent d'insuffisance nutritive, l'auteur indique que la plus grande perte pour l'agriculture résulte, non pas du nombre relativement petit d'animaux qui meurent pour cette raison, mais du grand nombre d'animaux qui ne sont pas en parfaite santé et qui ne donnent pas un rendement de 100% en tant que machines destinées à transformer les matières nutritives en produits animaux. L'auteur décrit des recherches intéressantes effectuées sur les conséquences pathologiques de la ration alimentaire chez deux tribus africaines et donne aussi un rapport concernant les habitudes alimentaires de 600 familles d'ouvriers dans les sept plus grandes villes d'Ecosse. Au cours d'une expérience sur la nutrition des moutons au pâturage on a trouvé que la santé de ces moutons était considérablement ameliorée par l'addition de grain, de sels de calcium et d'huile de foie de morue.

Croisement Naturel Chez le Ble, l'Avoine et l'Orge. J. B. Harrington, Universitié de la Saskatchewan, Saskatoon, Sask.

1) Des recherches à ce sujet furent entreprises pendant cinq ans à Saskatoon.

2) La moyenne du croisement naturel chez le blé s'est montrée de 0.88%, variant de 0.00% à 2.16%. La moyenne pour l'avoine vètue s'est montrée de 0.07%, variant de 0.00% à 0.20% et pour l'avoine nue, variété "Liberty", la moyenne s'est élevée à 3.68%, variant de 0.51% à 9.82%. Pour l'orge barbue la moyenne a été de 0.07%, variant de 0.00% à 0.17%, et pour la variété "White Hulless", de 0.16%, variant de 0.00% à 0.37%.
3) Tandis qu'il y a de grandes différences résultant de la nature de l'espèce végétale considérée les effets saisonniers ne semblent pas très importants. Cependant les résultats semblent indiquer une plus grande tendance au croisement naturel chez le blé et chez l'orge dans une saison humide que dans une saison sèche.

Vie et Habitudes du Pandemis Limitata Rob. en Nouvelle Ecosse. F. C. Gilliatt, Laboratoire fédéral d'entomologie, Annapolis Royal, Nouvelle Ecosse.

L'auteur donne une description de l'insecte et discute les conditions dans lesquelles l'importance de ses ravages est la plus grande. Les plus grands dégâts sont occasionnés aux fruits.

La Gomme des Blessures Chez le Pecher et Chez la Vigne. Son influence sur les attaques des parasites cryptogamiques des blessures. R. S. Willison. Laboratorie Fédérale de Pathologie Végétale, St. Catharines, Ontario.

La première partie de cette thèse a parue aux pages 402 à 419 dans le numéro de mars 1932 de cette revue.

Quand certaines cellules du bois ou de l'écorse du pêcher meureut, ayant été exposées à certaines conditions d'humidité et de température, les produits de décomposition suintent dedans les vaisseaux et forment des tampons. Ceux-ci durcissent et deviennent insolubles dans l'eau chaude et l'eau froide. La présence de cette gomme des blessures dans le bois du pêcher ralentit la vitesse de l'extension des chancres du *Cytospora,* mais elle ne l'empêche pas. D'un autre côté, elle paraît à empêcher l'extension des chancres du *Sclerotinia.*

En cas de blessures chez la vigne, il ne se forment pas de tampons dans les vaisseaux, probablement parce que ceux-là sont déjà remplis d'une substance ressemblant de la gelée, formée de sève. Cette substance devient parfois jaune, et ressemble à la gomme des blessures, mais elle n'empêche pas la pénétration du bois par le *Cryptosporella viticola* (qui cause la "branche moribonde" de la vigne).

CURRENT PUBLICATIONS

66. Eckstein, O., Jacob, H. and Alten, F. Arbeiten über Kalidüngung. (Investigations on Potash Fertilization). Verlagsgesellschaft für Ackerbau, Berlin, S.W. 11, 1931. pp. 237.

It is remarkable all the world over. In times of normal prosperity, industries are established and subsidized at the cost of agriculture, which is the backbone of every country. But when times are bad, and where are they not at the moment, then a sudden and belated interest in agriculture becomes manifest.

The book under review shows that Germany once more is becoming seriously interested in re-establishing her exploited agriculture, for such a tendency is indicated by the establishment, under the direction of eminent men, of a special research institute, devoted exclusively to problems of potash in agriculture.

The book describes in detail the Potash Experimental Station situated near Berlin. The problems to be taken up are discussed. These include not only the relation of potash to plant life, but also its effect upon the human and animal organism. Several of the ten sections on problems are of special note, particularly, perhaps, that on potash salts as a protection against disease. It is claimed that the application of sufficient potash will result in robust resistant plants, which will not suffer so readily from disease. We doubt whether such is the case, but readily agree that the yield and quality would probably be improved.

The book is valuable for many reasons. The organization and equipment of the Research Station are shown in detail, and the problems are well outlined and cover a wide range. The illustrations are good and instructive. —H.T.G.

67. AN IMPORTANT BREEDING PLACE OF CLOTHES MOTHS IN HOMES. G. J. Spencer, Canadian Entomologist, Vol. LXIII., No. 9, September, 1931.

It was found that the rectangular shafts of the hot air heating system of a house in Vancouver, B.C., contained deposits of fluff where the vertical shafts joined the horizontal shafts leading to the furnace. These deposits were found in shafts opening either on the wall or on the floor. During a period of four months the accumulation of this fluff from a portion of the sweepings of a much used room was sufficient to attract the moths. Both *Tineola bisselliella*, Humm and *Tinea pellionella*, L were present.

68. THE VITAMINS. By H. C. Sherman and S. L. Smith. 2nd Edition. A.C.S. Monograph No. 6. 525 Pages. $6.00.

The appearance of this monograph is a welcome one and a needed one. Progress in vitamin research during the past decade has been most rapid; the literature on the subject has become very voluminous. In consequence, the time is opportune for an authoritative compilation and arrangement of all the information now established concerning vitamins. This compilation and arrangement the authors have done in a satisfactory manner.

In their book they report on the history, properties, functions, occurrence and assay of each of the six established vitamins. In so doing, a conscious effort seems to have been made to present an unbiased and uncritical resume of the literature upon the subject. The latter has evidently been very completely surveyed. Commencing from the early historical beginnings, the development of vitamin research has been traced down to about the middle of 1930. In selecting the various citations, care has been taken that the information should be reasonably comprehensive without making the book unduly burdensome for the reader. Important considerations such as the concentration and the assaying of the vitamins as well as the interpretation of feeding trials have been considered in detail. Where necessary, curves and illustrations have been included to clarify the various points.

In addition to an author and subject index, the book contains a bibliography of some two hundred pages. —C.J.W.

69. AMELIORER UNE FERME (HOW TO IMPROVE A FARM). L. Philippe Roy, Quebec Department of Agriculture, Bulletin 106, published in French only.

This Bulletin is worthy of mention because of the attractive make up and also for the reason that it undertakes to apply data obtained on demonstrations farms to commercial undertakings. It contains many attractive illustrations and is divided into five parts.

In Part I the author makes a short farm management study regarding the farm production in various sections best suited for some types of farming, the farm capitalization, the most convenient size of farms and gives a few pointers on the selection of a good farm. In Part II he discusses the best combination of the main enterprise with the specialized production. He states that in Quebec the main enterprise on most farms is the dairy business with hog raising as a side line. In regard to specialized production the farmer has the choice between the poultry business, potatoes, garden crops, apples and small fruits, tobacco, commercial seed production, maple sugar, bee keeping, pure bred livestock, sheep, beef cattle and horse raising. In Part III the author outlines the crop rotations to be followed in various cases, the best grass mixtures to be used, the rate of seeding, the pasture management and the protection of plants against insects and fungus diseases. In Part IV he describes the farm layout—the replanning of old farm divisions if necessary for the convenience of a new type of rotation and the use of modern machinery. The farm plans used are very typical of those in the older districts of Quebec. They form long and narrow strips of land, sometimes two miles in length and only 180 yards in width. This type of division of lands was popular in early days of the French settlements since it was very important to group the settlers as close as possible in order to offer a better protection against the attacks of Indians and also to shorten the distance from the farm to the village, and at that time boats and not motor trucks were in use for long distance hauling. Today it is a very difficult problem to plan a convenient layout of these farms. In Part V the author discusses the various farms and types of drainage the use of fertilizers, the preparation and cultivation of land, the use of good seed. —A.G.

CONCERNING THE C.S.T.A.

AGRICULTURE AND GOVERNMENT BUDGETS

In company with other branches of government service, provincial and federal departments of agriculture are facing drastic reductions in appropriations in order to assist in balancing budgets. Department officials are willing and glad to do their part in meeting a critical situation. Just to what extent appropriations may be reduced without seriously impairing the efficiency of various branches of the service is an important matter, a matter on which the advice of experienced heads of departments should be the deciding factor. In considering reductions in appropriations to agricultural departments and institutions there are three points which legislators should keep in mind: first, the unorganised state of agriculture; second, the responsibility of governments in meeting this unorganised condition; and third, the efficiency and economy with which Canadian agriculture has been served.

I. Agriculture is an industry marked by the highly individualistic activities of its producers and distributors. In manufacturing it may be stated as a general principle that a few men can determine policies of production and marketing for a given product, and then issue orders to carry out these policies. With the assistance of skilled labour a standardized product appears on the market to be distributed by a carefully selected and well directed sales force. At all times during the process of production the individual workman is under strict supervision, and many industries exercise considerable control over their distribution systems also.

In agriculture, the leaders have practically no control over the individual producer. Grading laws enforced by the governments have guaranteed that high quality farm products will reach the consumer, and have been of immense benefit in stimulating consumption, but there is no control over methods of production, costs of production, or quantity of production; there is no production manager to guarantee that once a market is available there will be goods to supply it, or that once a market is glutted, goods will be withheld. While admitting that manufacturing does not handle these matters perfectly, the contrast stands. The farmer maintains his individuality; he can be led, but not driven, and progress in agriculture is made only on the basis of good will and confidence on the part of the farmer toward those who seek to lead him. This fact is fundamental in any consideration of agrarian policy.

II. Governments of all countries have recognized this situation, and have taken upon themselves the task of directing this unorganised industry, first to ensure an abundant food supply for their own people, and second as a means of increasing the wealth of the nation through export trade. The growth of this branch of government service has of necessity been rapid in all countries during the past quarter of a century. With increasing density of population, the struggle against plant and animal diseases and insect pests has become more intense. With greater skill in production and marketing, competition on world markets has become keener. World prices for food products have come to determine our domestic prices, as in Anglo-Saxon countries there is a limit to the height of tariffs against the importation of food products beyond which no government dares to go.

In all countries the rapid development of agricultural production has been based upon a wide-spread application of the discoveries of science, in short upon the knowledge of the technical agriculturist. His skill, whether directed by purely commercial or cooperative enterprises or by government departments has been the force which has assured the white races of a certain and inexpensive food supply. After all is said, the problem of marketing this supply can be handled only to a limited extent by governments owing to their lack of control over production and their general desire to interfere with normal business activities as little as possible. All attempts at marketing improvement, regardless of what organization sponsors them, must rest on a solid foundation of low-cost, high-quality production, and the maintenance of this foundation on a competitive basis with other countries requires constant vigilance. With the distribution systems of the world out of adjustment at the present time, there is too much of a tendency to emphasize what has not been accomplished in marketing, and to overlook the immense strides made by scientific agriculture toward the conquest of the stubborn forces of nature.

III. In this agricultural development, Canada has been placed in the front rank of the agricultural nations of the world. The achievements of the technical staffs of our provincial and federal departments and institutions are too well known to require enumeration. Nor have these achievements been purchased at too high a cost. It may come as a surprise to learn that the total cost of all the services of these departments and institutions, both provincial and federal, amounts to an annual charge of a little less than thirty-five cents per acre on the field crops of Canada. (Total provincial and federal expenditures approximated $20,000,000 in 1930 and had been reduced previous to 1932 budgets; total field crops exceed 60,000,000 acres). Improved varieties of inspected seed more than pay the total bill annually. This leaves no charge whatever against any pasture lands, garden and fruit crops, live stock, or live stock products. For this small sum, charged against his field crops only, the farmer has available all the research activities and extension teaching in methods of production and marketing of all kinds of crops and animal products, all the protection against the importation and spread of diseases and insect pests, all the protection and development of markets brought about by grading, and the services of all the colleges and schools equipped to educate each new generation of farmers in advanced agricultural practices. His expenditure is returned to himself and the nation many-fold each year. It should be obvious that the maintenance of such a valuable service at such a low cost to the farming industry could not have been accomplished without a high degree of efficiency and integration.

Looking back over the development of the provincial and federal services it is possible to detect over-emphasis on some policies, under-emphasis on others, and, in some cases, paternalism to a fairly high degree. It is easy to criticise these points, but it must be kept in mind that when these policies were framed they represented an honest endeavour to give the farmer service and leadership. In spite of much that has been written and said under the stress of present conditions, the leadership in which the farmer still has the most confidence is in the ranks of those men equipped by technical training and long experience to handle his problems. The need for the leadership which the technical service is capable of rendering was never so great. Provinces compete with each other and against other countries for domestic markets. The Dominion competes in world markets. Costs of production must be kept low, waste must be eliminated, and distribution methods must be improved. Canada faces competition in many forms, varying from the actual competition of the highly organized educational methods of Denmark to the potential competition of the coercive methods of Soviet Russia. There is no time to waste, no ground to be lost. The farms of the nation produce in normal times practically fifty per cent of the value of our exports, and even in these times will account for probably one third of the total. Agriculture remains the largest single factor in producing a favorable balance of trade. In directing agrarian policy governments have undertaken to handle an exceedingly important and complex problem; the advice of their technical men regarding the maintenance of essential services to Canadian agriculture is worthy of the highest respect in these critical times. —H.L.T.

C.S.T.A. ANNUAL ELECTION

Ballots for the election of officers of the Society for the year 1932-33 have been mailed to all members. Mailing lists have been carefully checked and if any member has not received his ballot, he will be forwarded one immediately upon application to the General Secretary. Ballots must be returned in time to reach the head office of the Society by April 20th. An excellent list of nominations was received and results are being awaited with interest.

Hon. Dr. A. Godbout, Minister of Agriculture for the Province of Quebec, has been elected French Vice-President by acclamation.

WINNIPEG CONVENTION

If the enthusiasm of the Manitoba members of the Society is any criterion, there will be a rousing C.S.T.A. Convention at Winnipeg during the week of June 13th. Arrangements are well under way to secure several prominent lecturers, and a well rounded programme is assured. While there will be some very important business for the Society to act upon, it is planned to keep the way clear as much as possible for special lectures and reports of standing committees. Programmes will be published in the May issue of Scientific Agriculture.

RETIREMENT OF DR. GRISDALE

On March 9th the announcement was made in the House of Commons that Dr. J. H. Grisdale, Deputy Minister of Agriculture for Canada, had requested his superannuation on account of ill health and that his resignation had been accepted with regret.

Dr. Grisdale's service to Canadian agriculture covers practically the first third of the twentieth century. This period, marked by the rapid development of science in relation to agriculture, witnessed the growth of the Dominion Experimental Farm System, and the Dominion Department of Agriculture. In the development of these services Dr. Grisdale played a leading part. His long and wide experience on the Experimental Farm staff, and later his duties as Director of the System, fitted him well for the position of Deputy Minister which he assumed in 1919.

His practical farm experience, and his wide knowledge of the conditions and problems of Canadian agriculture made him equally at home at a farmer's meeting or in the councils of the state, in the English language or in the French. He was listened to with respect in every corner of the Dominion, and represented Canada on many important missions to the Old Country. In addition to his wide knowledge and soundness of judgment, Dr. Grisdale possessed outstanding executive ability; he was in a position to give leadership, and he led. His mark has been placed on Canadian agriculture for the immeasurable benefit of the industry.

On occasions when he could find time to attend C.S.T.A. meetings, his presence as chairman or as a debater was always an event to be remembered with pleasure. His sympathy and support did much to strengthen the work of the Society as a whole. Members who heard of his misfortune in being ship-wrecked on his way to Bermuda to recuperate from his illness will be pleased to learn that he is none the worse for this experience and that he is making steady progress toward recovery.

NOTES AND NEWS

C. E. Ste. Marie (McGill '28) of the Division of Illustration Stations, Central Experimental Farm, Ottawa, is taking Post Graduate work at Cornell University with mailing address at 424 Seneca St., E.

S. C. Hudson (McGill '30), Field Assistant, Agricultural Economics Branch, Department of Agriculture, Ottawa, is taking Post Graduate work at Cornell and is also located at 424 Seneca St., E.

G. L. Haslam (McGill '30), Tobacco Assistant, Tobacco Division, Central Experimental Farm, Ottawa, is taking Post Graduate work at Cornell and is located at the same address as the two men above.

Dr. W. P. Thompson (Toronto '10, Harvard '14), Professor of Biology, University of Saskatchewan, recently gave two lectures on Genetics for the students of the graduate school of the University of Minnesota.

Dr. C. A. Zavitz (Toronto '88, Ohio '02) has returned from his usual winter in Florida to his home at R.R. 2, Ilderton, Ont.

K. F. Moffatt (British Columbia '28) is now located at Vernon, B.C.

Donald F. Patterson (McGill '27) who has been taking Post Graduate work in the Department of Chemistry, University of Toronto, has returned to his position of Junior Entomologist, Dominion Entomological Laboratory, Vineland Station, Ont.

K. H. Walker (Alberta '28) has changed his address from Raymond, Alta., to 9,716-111th Street, Edmonton, Alta.

Dr. T. H. Mather (Alberta '22, Minnesota '28) representing the Consolidated Mining and Smelting Company of Canada, has been transferred from Trail, B.C., to the Prairie office in the Toronto General Trusts Building, Calgary.

Antonio Besner (Montreal '23) has been transferred to Gaspé, where he holds the position of Agronome Officiel.